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INTERIM REPORT March 3, 1993

FOR

BIOVENTING FIELD INITIATIVE

AT

DOVER AIR FORCE BASE, DELAWARE

to

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by

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INTERIM REPORT

BIOVENTING FIELD INITIATIVE

DOVER AIR FORCE BASE, DELAWARE

1.0 INTRODUCTION

This report describes the activities conducted at Dover Air Force Base (AFB), Delaware, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE) and the Environmental Quality Directorate of the Air Force Armstrong Laboratory. This report summarizes the results from the first phase of the study at Dover AFB. First-phase activities include a soil gas survey, air permeability test, in situ respiration tests, and installation of bioventing systems. The specific objectives of this Bioventing Field Initiative are described in the following section. Each site at the base is discussed individually, followed by a description of site activities at the background area.

1.1 Objectives

The purpose of this Bioventing Field Initiative is to measure the soil gas permeability and microbial activity at a contaminated site in order to evaluate the potential application of bioventing technology to remediate the site. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil gas from the candidate site should exhibit high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location also will be identified.
- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined. To measure these parameters, air will be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.
- Immediately following the soil gas permeability test, an in situ respiration test will be conducted. Air will be injected into selected monitoring points to

aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

• The data from the soil gas permeability and in situ respiration tests will be used to determine an air injection/withdrawal rate for the bioventing test. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

1.2 Site Description

Dover AFB is located just east of the city of Dover, Delaware. A map of the base showing the locations of each site and the background area is shown in Figure 1. The dashed line on the map illustrates the direction from the main gate to each test site. Summaries of the descriptions of each site used for the Bioventing Initiative are presented in the following sections. A more detailed description of each test site is given in the Test Plan provided in Appendix A.

1.2.1 Site ST-04

Site ST-04 (Site D1 on Figure 1) is a gasoline release at the AAFES gas station. A map of the AAFES gas station is shown in Figure 2. The depth to groundwater at the site is approximately 11 feet. Soils consist predominantly of coarse sand and gravel from the ground surface to the water table. Analyses of soil samples showed contamination with benzene, toluene, ethylbenzene, and total xylenes (BTEX) at 11.5 feet to 13.5 feet. The highest concentrations detected were 180 ppm toluene, 80 ppm ethylbenzene, and 540 ppm total xylenes (benzene data not available). Soil samples from the 5- to 7-foot interval were below detection limit for BTEX and TPH. Sample data for the 7- to 11.5-foot interval were not available. A soil gas survey was conducted across the ST-04 site on 100- by 200-foot grids. The highest soil gas concentrations were found in the vicinity of the former leaking tank and the fuel-dispensing system.

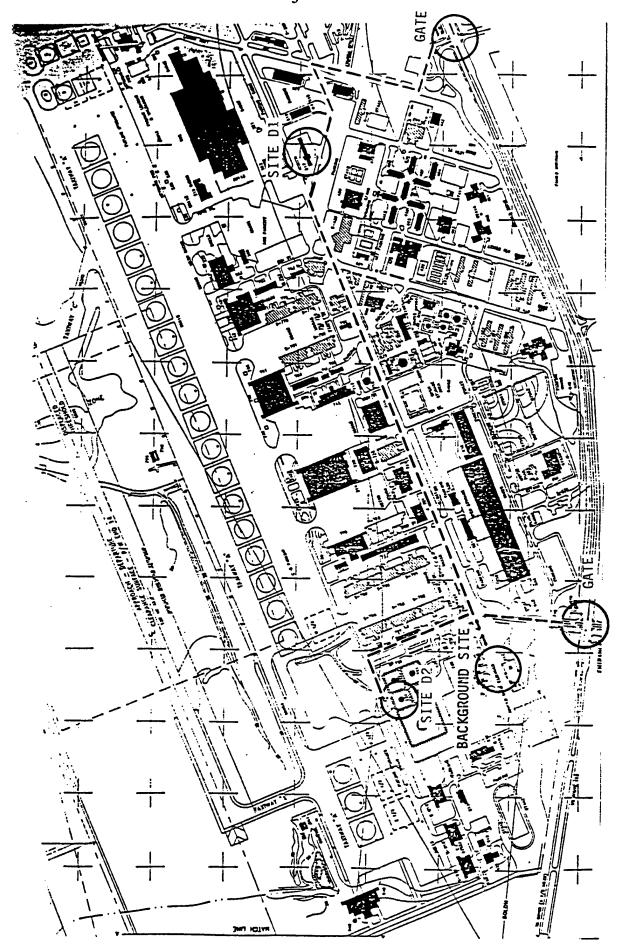


Figure 1. Schematic Diagram of Dover AFB

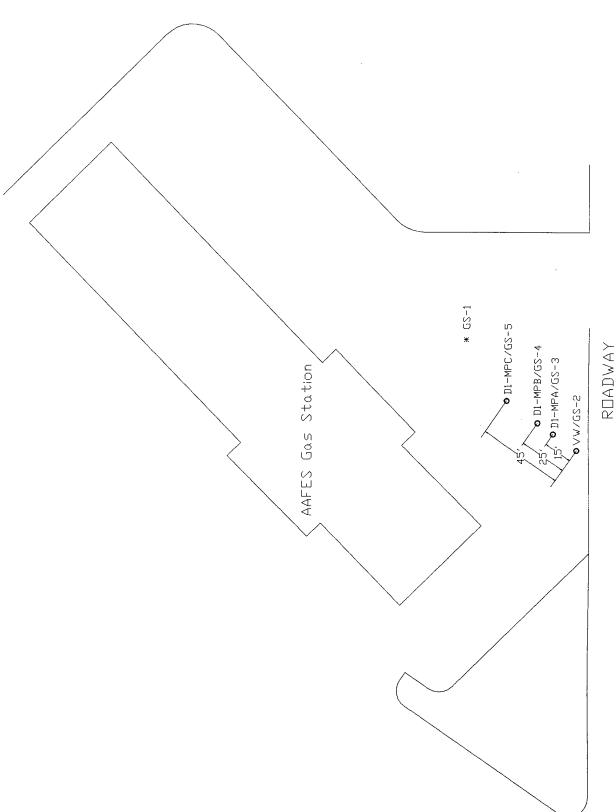


Figure 2. Schematic Diagram of Site ST-04 at Dover AFB (GS - Soil Gas Survey Point; MP - Monitoring Point)

1.2.2 North Storage Tank Farm

The North Storage Tank Farm (Site D2 on Figure 1) is an aboveground JP-4 jet fuel storage area shown in more detail in Figure 3. There have been three known releases from Tank 733 between 1970 and 1979 ranging from 17,000 gallons to 30,000 gallons of JP-4 jet fuel. Nearby surface soils include coarse sand and gravel, silt and silty sand, and clay and sandy clay. The water table at the site is approximately 10 feet. A soil gas survey was conducted across the site prior to the investigations described in this report. The soil gas data indicate the highest concentrations are adjacent to Tank 732, downgradient from Tank 733.

2.0 SITE ST-04

2.1 Chronology of Events and Site Activities

2.1.1 Groundwater Measurements

Two groundwater monitoring wells (MW 73S and MW 71S) were present at Site ST-04. The groundwater level was measured at these wells on November 3, 1992 and was recorded at 12.2 feet at MW 73S and 12.3 feet at MW 71S. No free product was detected in either well.

2.1.2 Soil Gas Survey

A suitable site for the bioventing demonstration should have soil gas characteristics of high TPH, low oxygen, and high carbon dioxide concentrations. This composition of soil gas would indicate that oxygen-limiting conditions for microbial activity are present and that the introduction of air may enhance biodegradation of TPH.

On November 2 and 3, 1992, a limited soil gas survey was conducted at Site ST-04. Soil gases were sampled by driving a %-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH.

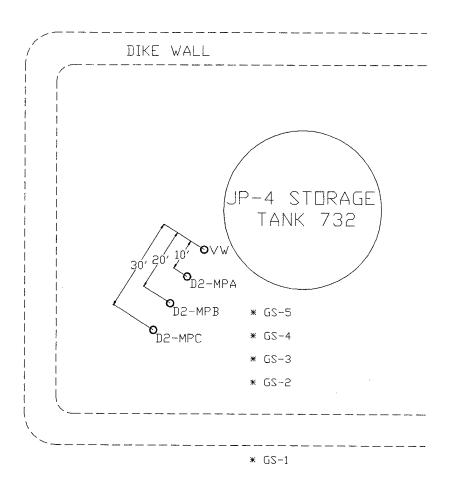


Figure 3. Schematic Diagram of the North Storage Tank Farm at Dover AFB (GS - Soil Gas Survey Point; MP - Monitoring Point)

Measurements of oxygen and carbon dioxide in the soil gas were made with a GasTech Model 32520X with oxygen and carbon dioxide ranges of 0 to 25%. The analyzer was calibrated daily against atmospheric oxygen, atmospheric carbon dioxide, a 10% oxygen calibration standard, and a 5% carbon dioxide calibration standard. TPH was measured with a GasTech Trace Techtor with TPH ranges from 0 to 100, 0 to 1,000, and 0 to 10,000 ppm. The GasTech Trace Techtor was calibrated daily against a 4,200-ppm hexane standard.

The soil gas probes were driven to depths ranging from 2.5 to 12.5 feet at several locations at Site ST-04. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site ST-04. Oxygen concentrations varied from 0 to 20.9%, and TPH concentrations ranged from 110 ppm to greater than 100,000 ppm. The oxygen concentrations in the soil gas indicate that most areas at this site are oxygen-limited and may respond to bioventing.

2.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On November 3 and 4, 1992, one vent well (VW) and three monitoring points (MPs) were installed at Site ST-04, and soil samples were collected for analyses. The monitoring points were labeled as follows: D1-MPA, D1-MPB, and D1-MPC. The locations of the vent well and monitoring points are shown in Figure 2. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 4.

The vent well was installed at a depth of 11.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with 5.0 feet of tenslot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes were sacrificial points consisting of ¼-inch tubing with an aluminum, 4-inch screened area. Sacrificial points were installed with a hammer drill in the same manner as the soil gas probes during the soil gas survey. No soil borings were created, nor was any sand added. A small amount of wetted bentonite was added at the surface. The monitoring points were installed at depths as follows:

Monitoring point D1-MPA was installed at the following three depths: 3.0,
 6.0, and 11.0 feet.

Table 1. Initial Soil Gas Composition at Site ST-04

| Soil Gas Survey (GS) Point | Depth (ft) | Oxygen (%) | Carbon Dioxide (%) | TPH (ppm) |
|-------------------------------|------------|------------|--------------------|-----------------------|
| GS-1 | 2.5 | 20.9¹ | 0 | 110 |
| | 5.0 | 2.6 | 13.1 | 50,000 |
| | 7.5 | 2.0 | 13.5 | 48,000 |
| | 10 | 2.5 | 13.2 | 54,000 |
| GS-2 | 5.0 | 5.9 | 9.1 | 75,000 |
| | 7.5 | 19.8¹ | 1.3 | 1,100 |
| | 10 | 4.0¹ | 13.0 | >40,000 |
| | 12.5 | 20.5¹ | 0.1 | 4,000 |
| GS-3 | 5.0 | 1.5 | 14.0 | >40,000 |
| | 7.5 | 0 | 15.1 | >40,000 |
| | 10 | 12.8¹ | 6.5 | 21,600 |
| GS-4 | 5.0 | 0.5 | 13.2 | 39,000 |
| | 7.5 | 0.3 | 15.0 | >100,000 ² |
| | 10 | 0.7 | 14.1 | >100,000 ² |
| GS-5 | 5.0 | 0 | 13.5 | >40,000 |
| | 7.5 | 0 | 13.5 | >40,000 |
| | 9.5 | 0 | 15.1 | >40,000 |

Pressure reading on sampling pump was high. Measured oxygen concentration may not be representative of actual soil gas oxygen concentrations. Actual oxygen concentration is likely to be lower.

² A 10:1 diluter was used for these readings. Due to weather conditions (heavy rains), the 10:1 diluter could not be used for other readings. A 4:1 diluter was used for the other readings.

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Figure 4. Cross Section of Vent Well and Monitoring Points at Site ST-04 Showing Site Lithology and Construction Detail (not to scale)

- Monitoring point D1-MPB was installed at the following depths: 3.0, 7.0, and 10.0 feet.
- Monitoring point D1-MPC was installed at the following depths: 3.0, 7.0, and 11.0 feet.

A Type J thermocouple was installed with monitoring points D1-MPA-3.0', D1-MPA-11.0', D1-MPB-3.0', and D1-MPB-10'.

2.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected from the vent well borehole at Site ST-04 at depths of 3.0 to 3.5 feet, 7.0 to 7.5 feet, and 11.0 to 11.5 feet and were labeled D1-VW-3', D1-VW-7', and D1-VW-11', respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size.

Soil gas samples were collected from monitoring points D1-MPA-11.0' and D1-MPC-11.0' and were labeled D1-MPA-11' and D1-MPC-11'. A sample also was collected of ambient air and labeled D1-AMBIENT. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

2.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection, the monitoring points at Site ST-04 were allowed to set up for 24 hours. Air was injected with a portable 1-horsepower (HP) explosion-proof positive displacement blower unit. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The HyperventilateTM computer model was used to calculate the soil gas permeability.

2.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at Site ST-04, air containing approximately 1% helium was injected into the soil for approximately 24 hours, beginning on November 13. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is given in the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: D1-MPA-11.0'; D1-MPB-7.0'; D1-MPB-10.0'; and D1-MPC-11.0'. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on November 18.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributed to either diffusion or leakage. A rapid drop in helium concentration followed by a leveling is an indication of leakage. A gradual loss along with an apparent first-order curve is an indicator of diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses about 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations are at least 50 to 60% of the initial levels at test completion, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

To compare data from one site to another, a stoichiometric relationship of the oxidation of the hydrocarbon was assumed. Hexane was used as the representative hydrocarbon for the organic contaminant. The stoichiometric relationship is given by:

$$C_6H_{14} + 9.5O_2 - 6CO_2 + 7H_2O$$
 (1)

Based on the utilization rates (percent per day), the biodegradation rates in terms of milligrams as a hexane equivalent per kilogram of soil per day were computed using the equation below by assuming a soil porosity of 0.2 and a bulk density of 1,440 kg/m³.

$$K_{\beta} = \frac{-K_{o}AD_{o}C}{100}$$
 (2)

where: K_8 = biodegradation rate (mg/kg/day)

 K_0 = oxygen utilization rate (percent per day)

A = volume of air/kg of soil, in this case 300/1,440 = 0.21

 D_o = density of oxygen gas (mg/L) assumed to be 1,330 mg/L

C = mass ratio of hydrocarbon to oxygen required for mineralization, assumed to be 1/3.5 from the above stoichiometric equation.

2.2 Results and Discussion

2.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at Site ST-04 are presented in Table 2. The analytical report for this site is presented in Appendix B. Concentrations of the BTEX compounds in soil were relatively low from depths of 3.0 and 7.0 feet with all compounds except toluene (0.0021 mg/kg to 0.0034 mg/kg) measured below the detection limit. TPH was 7.0 mg/kg at a depth of 7.0 feet, but was below the detection limit (<4.0 mg/kg) at a depth of 4.0 feet. Soil samples measured from a depth of 11.0 feet ranged from 2.7 mg/kg (benzene) up to 26 mg/kg (total xylenes), and TPH was 17 mg/kg. Concentrations of BTEX in soil vapor samples from a depth of 11.0 feet ranged from 6.8 ppmv (ethylbenzene) up to 79 ppmv (total xylenes), and TPH concentrations were measured at 33,000 ppmv and 34,000 ppmv (Table 2). Vapor samples taken of ambient air showed relatively low concentrations of BTEX and TPH. The results of the soil chemistry analyses are summarized in Table 3.

2.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Site ST-04 are presented in Appendix C. Using the HyperventilateTM computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 4. The soil gas permeability varied

Table 2. Results From Soil and Soil Gas Analyses for BTEX and TPH at Site ST-04

| Matrix | Sample Name | Benzene (mg/kg) | Toluene (mg/kg) | Ethylbenzene (mg/kg) | Total Xylenes (mg/kg) | TPH¹ (mg/kg) |
|-----------------|------------------------|--------------------|--------------------|-------------------------|-----------------------------|-----------------|
| Soil | D1-VW-3' | < 0.00060 | 0.0021 | < 0.00050 | < 0.0010 | <4.0 |
| | D1-VW-7' | < 0.00070 | 0.0034 | < 0.00060 | < 0.0010 | 7.0 |
| | D1-VW-11' | 2.7 | 3.2 | 5.0 | 26 | 17 |
| | | | | | Total | |
| Matrix | Sample Name | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Xylenes (ppmv) | TPH² (ppmv) |
| Matrix Soil Gas | Sample Name D1-MPA-11' | | | • | Xylenes | |
| | | (ppmv) | (ppmv) | (ppmv) | Xylenes (ppmv) | (ppmv) |

¹ Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

² TPH referenced to jet fuel (molecular weight = 156).

Table 3. Results From Soil Chemistry Analyses at Site ST-04

| | Sample Name | | | | | |
|---------------------------------------|-------------|------|----------|------|-----------|------|
| Parameter | D1-V | W-3′ | D1-VW-7' | | D1-VW-11' | |
| Alkalinity (mg/kg CaCO ₃) | 5 | 3 | <5 | 50 | < 50 | |
| Moisture (% by weight) | 8. | 8 | 14. | 1 | 12. | .1 |
| рН | 6.6 | | 4.6 | | 4.8 | |
| Iron (mg/kg) | 7,4 | 20 | 3,230 | | 3,450 | |
| Total Phosphorous (mg/kg) | 31 | 0 | 240 | | 260 | |
| Total Kjeldahl Nitrogen (mg/kg) | 78 | 3 | 36 | 5 | 31 | |
| Particle Size (%) | Gravel: | 1 | Gravel: | 4.5 | Gravel: | 25.5 |
| | Sand: | 53 | Sand: | 60 | Sand: | 48 |
| | Silt: 33 | | Silt: | 19 | Silt: | 17 |
| | Clay: | 13 | Clay: | 16.5 | Clay: | 7.5 |

Table 4. Results of Hyperventilate™ Soil Gas Permeability Analysis at Site ST-04

| Monitoring Point | Depth (ft) | Soil Gas Permeability (darcy) |
|------------------|------------|-------------------------------|
| D1-MPA | 3.0 | 12 |
| | 6.0 | 8.5 |
| | 11.0 | 3.9 x 10 ⁸ |
| D1-MPB | 3.0 | NM |
| | 7.0 | 34 |
| | 10.0 | 2.6 x 10⁴ |
| D1-MPC | 3.0 | 1.7 |
| | 7.0 | NM |
| | 11.0 | NM |

NM No pressure change was measured at this monitoring point.

considerably, with values ranging from 1.7 darcy up to 3.9×10^8 darcy. The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well. The radius of influence would then be the distance where 1-inch of water pressure can be measured. Therefore, the radius of influence based on these specifications is approximately 32 feet (Figure 5).

2.2.3 In Situ Respiration Test

The results of the in situ respiration test for Site ST-04 are presented in Appendix D. Each figure in Appendix D illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 6, where oxygen utilization and carbon dioxide production at monitoring point D1-MPA-11.0' are illustrated. A summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 5. The biodegradation rates measured at this site were fairly high, with rates ranging from 2.9 mg/kg/day to 3.8 mg/kg/day based on oxygen utilization, and from 0.65 mg/kg/day to 1.5 mg/kg/day based on carbon dioxide production. Soil gas samples could not be collected from monitoring point D1-MPB-10.0' due to soil conditions in this area; therefore, the data from this monitoring point is not presented.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 13.9°C to 16.0°C at monitoring point D1-MPA-11.0′.

2.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at Site ST-04. A 1-HP blower was installed at the site on November 11, 1992. The blower was run for 90 minutes in an extraction mode to measure the concentrations of BTEX and TPH in the exhaust gas. Exhaust gas concentrations of these compounds were as follows: benzene (65 ppmv); toluene (100 ppmv); ethylbenzene (23 ppmv); total xylenes (79 ppmv); and TPH (83,000 ppmv). The analytical report for these analyses is given in Appendix B. Air extraction was not initiated for the long-term bioventing test pending installation of electricity at the site and regulatory approval for operation of the unit.

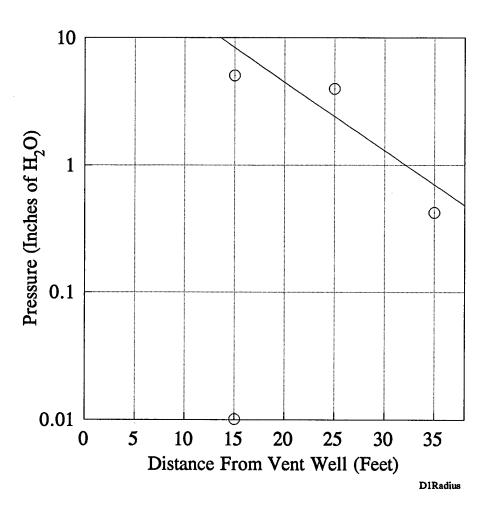


Figure 5. Radius of Influence at Site ST-04

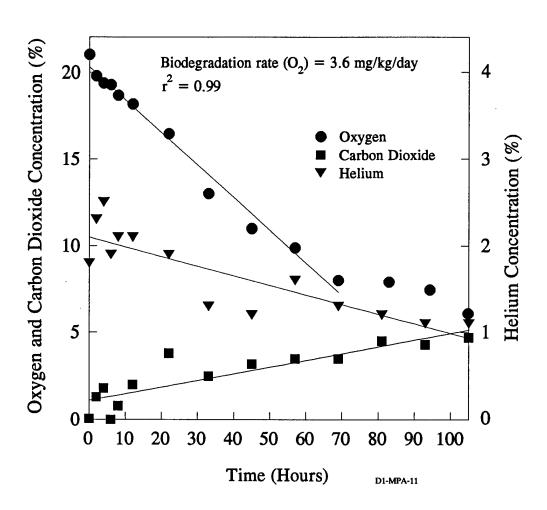


Figure 6. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPA-11.0'

Table 5. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at Site ST-04

| Sample Name | Oxygen Utilization Rate (%/hour) | Biodegradation Rate (mg/kg/day) | Carbon Dioxide Production Rate (%/hour) | Biodegradation Rate (mg/kg/day) |
|--------------|----------------------------------------|---------------------------------------|-----------------------------------------------|---------------------------------------|
| Background | 0.0030 | 0.060 | 0 | 0 |
| D1-MPA-11.0' | 0.19 | 3.6 | 0.045 | 0.97 |
| D1-MPB-7.0' | 0.15 | 2.9 | 0.030 | 0.65 |
| D1-MPC-11.0' | 0.20 | 3.8 | 0.069 | 1.5 |

3.0 NORTH STORAGE TANK FARM SITE

3.1 Chronology of Events and Site Activities

3.1.1 Groundwater Measurements

Groundwater is typically encountered at a depth of approximately 10 feet in this area. During vent well installation, groundwater was encountered at a depth of 11 feet.

3.1.2 Soil Gas Survey

On November 7 and 8, 1992, a limited soil gas survey was conducted to locate a suitable test area at the North Storage Tank Farm. Soil gases were sampled by driving a %-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Soil gas measurements were taken as described in Section 2.1.2.

The soil gas probes were driven to depths ranging from 1.5 to 11.0 feet at several locations at the North Storage Tank Farm. Table 6 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at the North Storage Tank Farm. Relatively low concentrations of oxygen were found at most of the soil gas probes, with concentrations ranging from 0 to 19.8%. Relatively high concentrations of carbon dioxide (0 to 11.5%) and TPH (60 ppm to greater than 40,000 ppm) were encountered. Soil gas samples taken at this site were often difficult to obtain, probably due to the high moisture content in the soil from several days of heavy rain.

3.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On November 8, 1992, one vent well and three monitoring points were installed at the North Storage Tank Farm, and soil samples were collected for analyses. The monitoring points were labeled D2-MPA, D2-MPB, and D2-MPC. The locations of the vent well and monitoring points are shown in Figure 3. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 7.

Table 6. Initial Soil Gas Composition at the North Storage Tank Farm

| Soil Gas Survey (GS) Point | Depth (ft) | Oxygen (%) | Carbon Dioxide (%) | ТРН (ррт) |
|-------------------------------|------------|------------|--------------------|-----------|
| GS-1 | 2.5 | 19.8¹ | 0 | 60 |
| | 7.5 | 19.8¹ | 0 | 220 |
| | 8.6 | 13.5¹ | 4.7 | 7,600 |
| GS-2 | 2.5 | 0 | 11.0 | >40,000 |
| GS-3 | 2.5 | 0 | 11.5 | >40,000 |
| | 5.0 | 0 | 11.0 | >40,000 |
| | 11.0 | NS | NS | NS |
| GS-4 | 1.5 | 0 | 11.5 | >40,000 |
| | 2.5 | 0 | 11.5 | >40,000 |
| GS-5 | 1.5 | 0 | 11.5 | >40,000 |
| | 2.5 | 6.0¹ | 9.0 | >40,000 |

NS Not sampled. Water was encountered at this depth.

Pressure reading on sampling pump was high. Measured oxygen concentration may not be representative of actual soil gas oxygen concentrations. Actual oxygen concentration is likely to be lower.

MPC

MPB

MPA

Vent Well

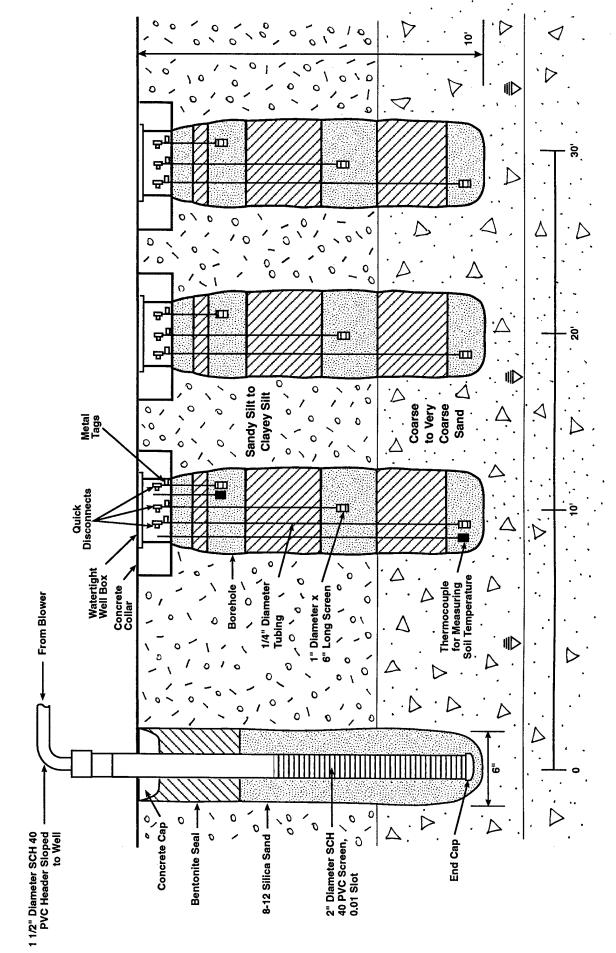


Figure 7. Cross Section of Vent Well and Monitoring Points at the North Storage Tank Farm Showing Site Lithology and Construction Detail (not to scale)

F/Kittel11/d-2

No flow could be obtained through the vent well which was initially installed, so a second vent well was installed next to the first on November 17. The second vent well was installed at a depth of 10.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, and the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were all installed at depths as follows: 2.5, 6.0, and 9.5 feet.

A Type J thermocouple was installed with monitoring points D2-MPA-2.5' and D2-MPA-9.5'.

3.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected from the vent well borehole at the North Storage Tank Farm at depths of 3.0 to 3.5 feet, 3.5 to 4.0 feet, 7.0 to 7.5 feet, 7.5 to 8.0 feet, and 10.0 to 10.5 feet and were labeled D2-VW-3', D2-VW-3.5'-4', D2-VW-7', D2-VW-7.5'-8.0', D2-VW-10', and D2-VW-10'-10.5', respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size.

Soil gas samples were collected from the vent well and from monitoring points D2-MPA-2.5', D2-MPB-2.5', and D2-MPC-2.5' and were labeled D2-VW-3'-8', D2-MPA-2.5', D2-MPB-2.5', and D2-MPC-2.5'. A sample also was collected of ambient air and labeled D2-AMBIENT. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

3.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection, the monitoring points were allowed to set up for 24 hours. A portable 1-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The HyperventilateTM computer model was used to calculate the soil gas permeability.

3.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at the North Storage Tank Farm, air containing approximately 1% helium was injected into the soil for approximately 24 hours, beginning on November 14, 1992. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is given in the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: D2-MPA-2.5'; D2-MPA-9.5'; D2-MPB-9.5'; and D2-MPC-2.5'. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on November 18.

3.2 Results and Discussion

3.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at the North Storage Tank Farm are presented in Table 7. The analytical report for this site is presented in Appendix B. The areas with the highest contamination appeared to be the shallow depths (3.5 feet to 4.0 feet), although benzene and toluene were not detected in any soil samples, except for a trace amount of toluene (0.0040 mg/kg) at a depth of 10.0 feet to 10.5 feet. TPH was detected in all soil samples with the highest concentrations in sample D2-VW-3.5'-4' (3,500 mg/kg). Soil vapor samples contained relatively high concentrations of BTEX and TPH, with concentrations ranging from below the detection limit (<5.0 ppmv) up to 7.6 ppmv (benzene) and from 3,800 ppmv up to 12,000 ppmv of TPH. Vapor samples taken of ambient air contained low concentrations of all constituents with concentrations ranging from below the

Table 7. Results From Soil and Soil Gas Analyses for BTEX and TPH at the North Storage Tank Farm

| Matrix | Sample Name | Benzene (mg/kg) | Toluene (mg/kg) | Ethylbenzene (mg/kg) | Total Xylenes (mg/kg) | TPH¹ (mg/kg) |
|--------|-----------------|--------------------|--------------------|-------------------------|-----------------------------|-----------------|
| Soil | D2-VW-3.5'-4' | <1.4 | <1.6 | 38 | 110 | 3,500 |
| | D2-VW-7.5'-8.0' | < 0.34 | < 0.40 | 0.51 | < 0.40 | 8.0 |
| | D2-VW-10'-10.5' | < 0.00090 | 0.0040 | < 0.00070 | < 0.0013 | 22 |
| Matrix | Sample Name | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Total Xylenes (ppmv) | TPH² (ppmv) |
| Soil | D2-VW-3'-8' | < 5.0 | < 5.0 | <5.0 | <5.0 | 12,000 |
| Gas | D2-MPA-2.5' | 7.6 | 6.7 | 1.7 | 5.3 | 4,800 |
| | D2-MPB-2.5' | 5.1 | 4.6 | 2.4 | 5.3 | 3,800 |
| | D2-MPC-2.5' | 6.3 | 5.4 | 3.2 | 8.3 | 4,000 |
| | D2-AMBIENT | 0.092 | 0.069 | < 0.010 | 0.082 | 150 |

Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

² TPH referenced to jet fuel (molecular weight = 156).

detection limit for ethylbenzene (<0.010 ppmv) to 0.092 ppmv for benzene, and only 150 ppmv of TPH was detected. The results of the soil chemistry analyses are summarized in Table 8.

3.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at the North Storage Tank Farm are presented in Appendix E. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 9. The soil gas permeability varied considerably, with values ranging from 0.0016 darcy up to 9.3 x 10° darcy. The radius of influence where 1 inch of water could be measured was calculated by plotting the log of the pressure change at the monitoring points versus the distance from the vent well (Figure 8). In general, the deeper depths at monitoring points D2-MPA and D2-MPB did not show a large pressure change. However, the monitoring points at D2-MPC all showed a consistent pressure change, indicating that it is possible that the deeper depths at monitoring points D2-MPA and D2-MPB may be obstructed in some way. Calculating the radius of influence at the North Storage Tank Farm without including the values from the deeper depths at monitoring points D2-MPA and D2-MPB, a value of 32 feet is estimated.

3.2.3 In Situ Respiration Test

The results of the in situ respiration test for the North Storage Tank Farm are presented in Appendix F. Each figure in Appendix F illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 9, where oxygen utilization and carbon dioxide production at monitoring point D2-MPA-2.5' is illustrated. A summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 10. The biodegradation rates measured at this site were fairly high, with rates ranging from 2.9 to 8.6 mg/kg/day based on oxygen utilization, and from 0.89 to 1.9 mg/kg/day based on carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 8.1°C to 10.3°C at monitoring point D2-MPA-2.5′ and from 13.9°C to 16.0°C at monitoring point D2-MPA-9.5′.

Table 8. Results From Soil Chemistry Analyses at the North Storage Tank Farm

| | Sample Name | | | | |
|---------------------------------------|-------------|-----------|-------------|--|--|
| Parameter | D2-VW-3' | D2-VW-7' | D2-VW-10' | | |
| Alkalinity (mg/kg CaCO ₃) | < 50 | < 50 | < 50 | | |
| Moisture (% by weight) | 12.8 | 29.5 | 32.3 | | |
| pН | 5.9 | 5.3 | 5.2 | | |
| Iron (mg/kg) | 1,950 | 16,200 | 8,070 | | |
| Total Phosphorous (mg/kg) | 64 | 110 | 140 | | |
| Total Kjeldahl Nitrogen (mg/kg) | 84 | 460 | 700 | | |
| Particle Size (%) | Gravel: 2.0 | Gravel: 0 | Gravel: 2.5 | | |
| | Sand: 67.5 | Sand: 17 | Sand: 17 | | |
| | Silt: 23 | Silt: 35 | Silt: 36.5 | | |
| | Clay: 7.5 | Clay: 48 | Clay: 44 | | |

Table 9. Results of Hyperventilate™ Soil Gas Permeability Analysis at the North Storage Tank Farm

| Monitoring Point | Depth (ft) | Soil Gas Permeability (darcy) | |
|------------------|------------|-------------------------------|--|
| D2-MPA | 2.5 | 92 | |
| | 6.0 | 0.0016 | |
| | 9.5 | 2.6 | |
| D2-MPB | 2.5 | 230 | |
| | 6.0 | 0.0024 | |
| | 9.5 | NR | |
| D2-MPC | 2.5 | 210 | |
| | 6.0 | 9.3 x 10° | |
| | 9.5 | 2.1 x 10° | |

NR No pressure readings were obtained at this monitoring point.

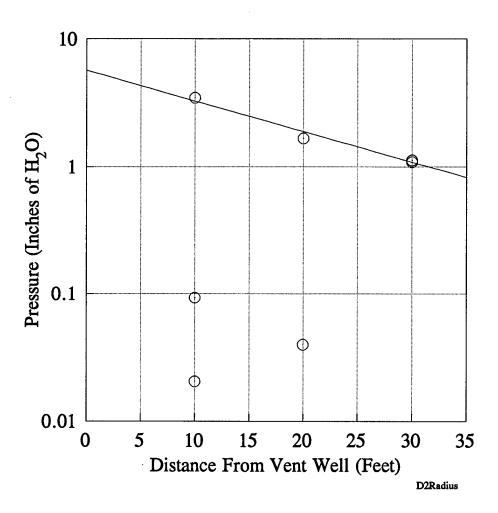


Figure 8. Radius of Influence at the North Storage Tank Farm

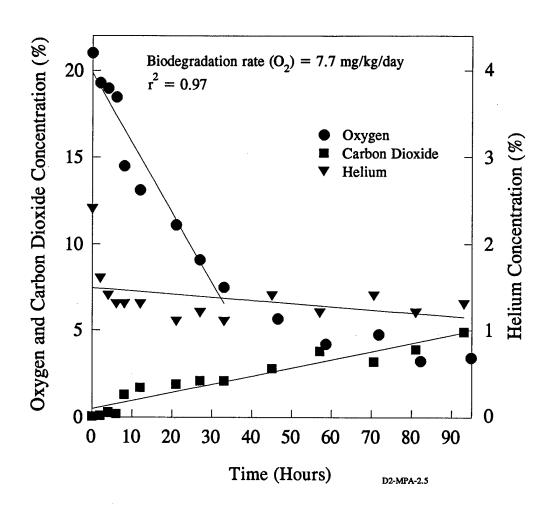


Figure 9. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-2.5'

Table 10. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the North Storage Tank Farm

| Sample Name | Oxygen Utilization Rate (%/hour) | Biodegradation Rate (mg/kg/day) | Carbon Dioxide Production Rate (%/hour) | Biodegradation Rate (mg/kg/day) |
|-------------|----------------------------------------|---------------------------------------|-----------------------------------------------|---------------------------------------|
| Background | 0.0030 | 0.060 | 0 | 0 |
| D2-MPA-2.5' | 0.40 | 7.7 | 0.069 | 1.5 |
| D2-MPA-9.5' | 0.45 | 8.6 | 0.086 | 1.9 |
| D2-MPB-2.5' | 0.21 | 4.0 | 0.041 | 0.89 |
| D2-MPC-2.5' | 0.15 | 2.9 | 0.045 | 0.97 |

3.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at the North Storage Tank Farm. A 1-HP blower was installed on November 12, 1992. Air injection has not been initiated at the site pending installation of an electrical supply.

4.0 BACKGROUND AREA

The background area was located as shown in Figure 1. The vent well was installed at a depth of 11.0 feet into an 8-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, whereas the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil samples were collected from the vent well borehole at depths of 3.0 to 3.5 feet, 3.5 to 4.0 feet, 7.0 to 7.5 feet, and 10.0 to 10.5 feet and were labeled D1-BG-3', D1-BG-3.5'-4.0', D1-BG-7', D1-BG-7.0'-7.5', D1-BG-10', and D1-BG-10.0'-10.5', respectively. A soil gas sample also was collected from the vent well after installation and was labeled D1-BG-6'-11'. The soil samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size analysis. The soil gas sample was sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH. The site lithology at this area was representative of that in the contaminated areas.

Results of the soil and soil gas analyses for BTEX and TPH are presented in Table 11. The analytical report for this site is presented in Appendix B. All of the BTEX compounds and TPH were at concentrations below the detection limit in the soil samples, except for a small quantity of toluene in samples D1-BG-7.0'-7.5' (0.0013 mg/kg) and D1-BG-10.0'-10.5' (0.0068 mg/kg). The soil vapor sample contained detectable concentrations of BTEX compounds, with concentrations ranging from below the detection limit for total xylenes (<0.010 ppmv) up to 0.092 ppmv (benzene). TPH was detected at 600 ppmv. The results of the soil chemistry analyses are summarized in Table 12.

Table 11. Results From Soil and Soil Gas Analysis for BTEX and TPH at the Background Area

| Matrix | Sample Name | Benzene (mg/kg) | Toluene (mg/kg) | Ethylbenzene (mg/kg) | Total Xylenes (mg/kg) | TPH¹ (mg/kg) |
|-------------|-----------------------|--------------------|--------------------|-------------------------|-----------------------------|-----------------|
| Soil | D1-BG-3.5'- 4.0' | < 0.00060 | < 0.00070 | < 0.00050 | < 0.0010 | <4.0 |
| | D1-BG-7.0'- 7.5' | < 0.00060 | 0.0013 | < 0.00050 | < 0.0010 | <4.0 |
| | D1-BG-10.0'- 10.5' | < 0.00070 | 0.0068 | < 0.00060 | < 0.0010 | <4.0 |
| Matrix | Sample Name | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Total Xylenes (ppmv) | TPH² (ppmv) |
| Soil Gas | D-BG-6.0'- 11.0' | 0.092 | 0.069 | 0.082 | < 0.010 | 600 |

Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

² TPH referenced to jet fuel (molecular weight = 156).

Table 12. Results From Soil Chemistry Analyses at the Background Area

| | Sample Name | | | | | |
|---------------------------------------|-------------|----|---------|-----|---------|--------|
| Parameter | D1-BG- | 3′ | D1-BG | -7′ | D1- | BG-10′ |
| Alkalinity (mg/kg CaCO ₃) | < 50 | | < 50 | | | < 50 |
| Moisture (% by weight) | 6.1 | | 5.4 | | | 10.5 |
| pН | 6.1 | | 5.3 | | | 5.5 |
| Iron (mg/kg) | 12,700 | | 1,970 | | 6,850 | |
| Total Phosphorous (mg/kg) | 330 | | 110 | | 230 | |
| Total Kjeldahl Nitrogen (mg/kg) | 210 | | <20 | l | | 35 |
| Particle Size (%) | Gravel: | 0 | Gravel: | 7 | Gravel: | 3.5 |
| | Sand: | 40 | Sand: | 74 | Sand: | 65.5 |
| | Silt: | 40 | Silt: | 14 | Silt: | 20 |
| | Clay: | 20 | Clay: | 5 | Clay: | 11 |

An in situ respiration test was conducted at the background area beginning on November 16, 1992 after 24 hours of air injection. The test was concluded on October 18. Very little decrease in oxygen concentration occurred during the course of the in situ respiration test (Figure 10).

5.0 FUTURE WORK

Once the system is operating, base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flowrate, pressure, and temperature range. An on-site briefing for base personnel who will be responsible for blower system checks will be conducted when the blowers are installed. The principle of operation will be explained, and a simple checklist and logbook will be provided for blower data. Base personnel will be asked to perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base and serious problems, such as motor or blower failures, will be corrected by Battelle.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. At least twice each year, the progress of the bioventing test will be reported to the base point-of-contact.

6.0 REFERENCE

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. Test Plan and Technical Protocol for a Field Treatability Test for Bioventing (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering-Science, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

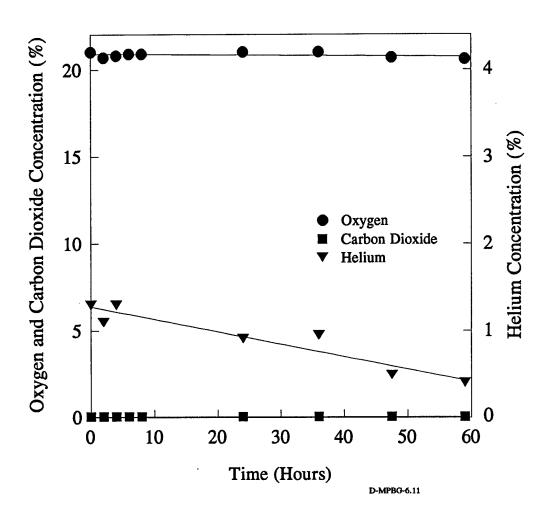


Figure 10. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Background Area

$\label{eq:appendix} \textbf{APPENDIX A}$ TEST PLAN FOR DOVER AFB, DELAWARE

October 15, 1992



505 King Avenue Columbus, Ohio 43201-2693 Telephone (614) 424-6424 Facsimile (614) 424-5263

Captain Catherine Vogel HQ AFCESA/RAVW 139 Barnes Drive Tyndall Air Force Base, Florida 32403-5319

Dear Cathy:

SUBJECT: TEST PLAN FOR BIOVENTING INITIATIVE FIELD TEST AT SITE ST-04 AND ZONE SP, DOVER AFB, DE

This letter was developed to accompany the report "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing." The test plan document was developed as a generic test plan for the Air Force Bioventing Initiative Project in which Dover AFB is participating. This letter outlines site specific information to support the generic test plan.

The sites chosen for the bioventing test initiative are Site ST-04 and Zone SP.

The purpose of this project is to investigate the feasibility of using the bioventing technology to remediate petroleum contaminated soils at the above mentioned sites.

Site descriptions-

Dover AFB is located just east of the city of Dover, Delaware. Summaries of the available descriptions of each site proposed for the Bioventing Initiative are presented below.

Site ST-04- Site ST-04 is a gasoline release site at the AAFES gas station. A map of the AAFES gas station is shown in Figure 1. The cross-sections A to A' and B to B' are presented in Figures 2 and 3, respectively. Depth to groundwater at the site is approximately 11 ft. Soils consist predominantly of coarse sand and gravel from the ground surface to the water table. Analytical results for soil samples from soil borings d66, d67, and d68 (see Figure 1) were contaminated with BTEX constituents at 11.5 ft. to 13.5 ft. The highest concentrations were detected in d67 with 180 ppm toluene, 80 ppm ethylbenzene, and 540 ppm total xylenes (benzene data not available). Soil samples from these borings from the 5 ft. to 7 ft. interval were below detection limit for BTEX and TPH. Sample data for the 7 ft. to 11.5 ft. interval was not available. A soil gas survey was conducted across the ST-04 site on 100 ft. by 200 ft. grids. Figure 4 presents the soil gas TPH concentrations. The highest soil gas concentrations are in the vicinity of the former leaking tank and the fuel dispensing system.

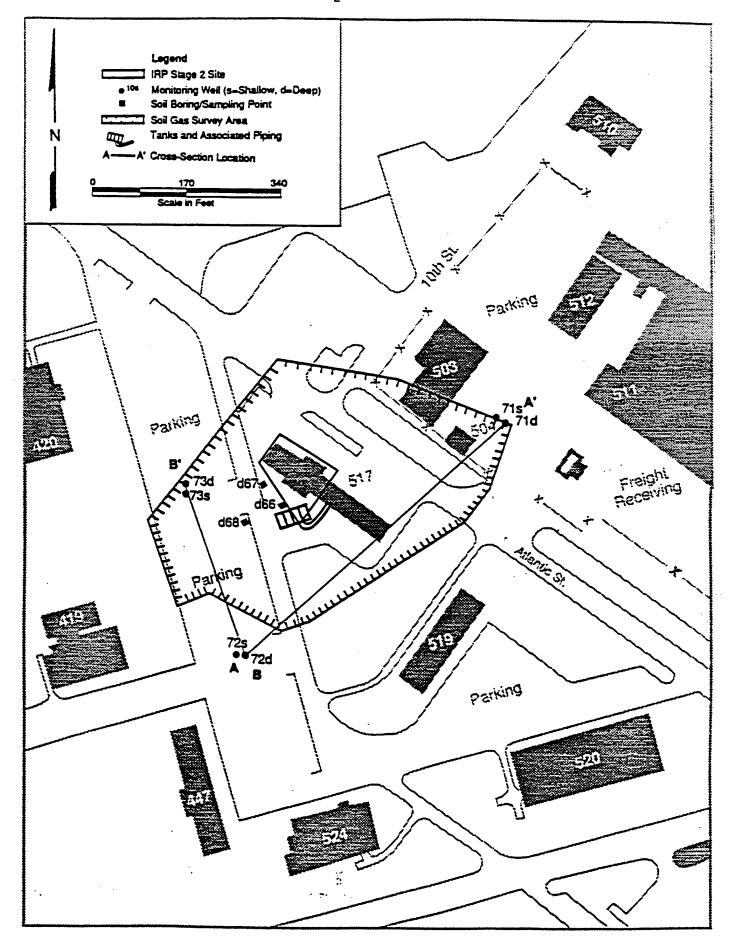


FIGURE 1. SITE MAP FOR ST-04 (AAFES GAS STATION LEAK).

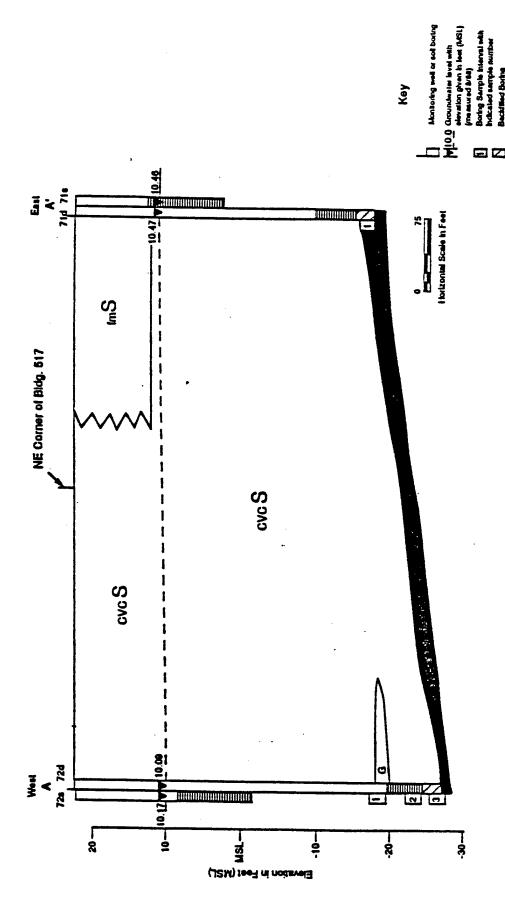


FIGURE 2. SITE ST-04 - CROSS-SECTION A-A'

Clay, sandy day, or olby day SR, sandy sR, or clayey sill fine -medum sand Coarse -very coarse sand (wha or without gave) Garve), sandy gavel Kibwood formation (predominanly clay)

Monitoring well or soil boring

Кву

410.0 Groundweler level with elevation given in feet (MSL)

Boring Sample Interval with

(measured 8/88)

indicated sample number

Backlilled Boring Screened Interval

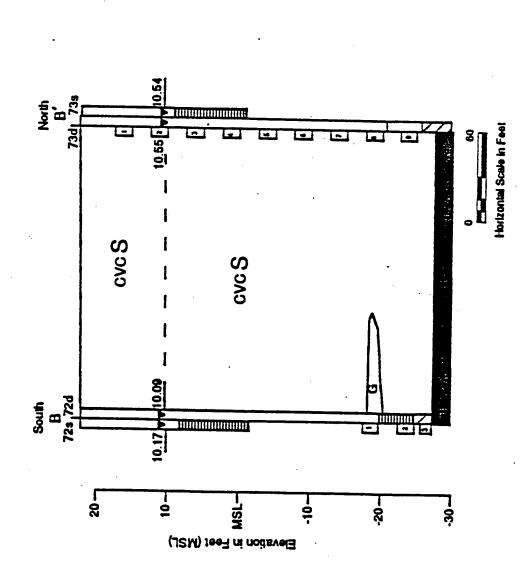


FIGURE 3. SITE ST-04 - CROSS-SECTION B-B'

Course -very course sand (with

Clay, sandy clay, or shy clay

Sill, eandy silt, or clayey eft

Fine -medium sand

or without grave)
Gravel, sandy gravel
Kirlewood formation (predorrinantly clay)

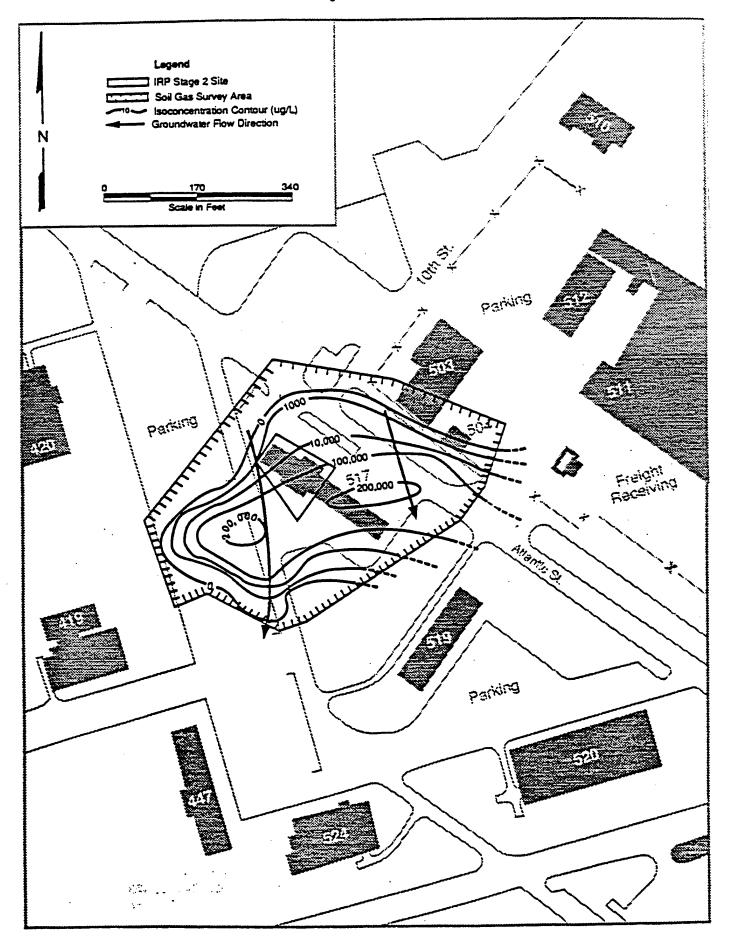


FIGURE 4. SITE ST-04: TPH CONCENTRATIONS IN SOIL GAS.

Based on the site data for Site ST-04 the most likely area for the installation of the bioventing well is adjacent to UST cavity near soil boring d67. This area is covered with asphalt and is near the service station building. It is likely that the blower installed here would have to be configured for withdrawal of soil gas rather than for air injection. Regulatory approval will be required prior to initiation of the long-term bioventing test if the blower is configured for withdrawal.

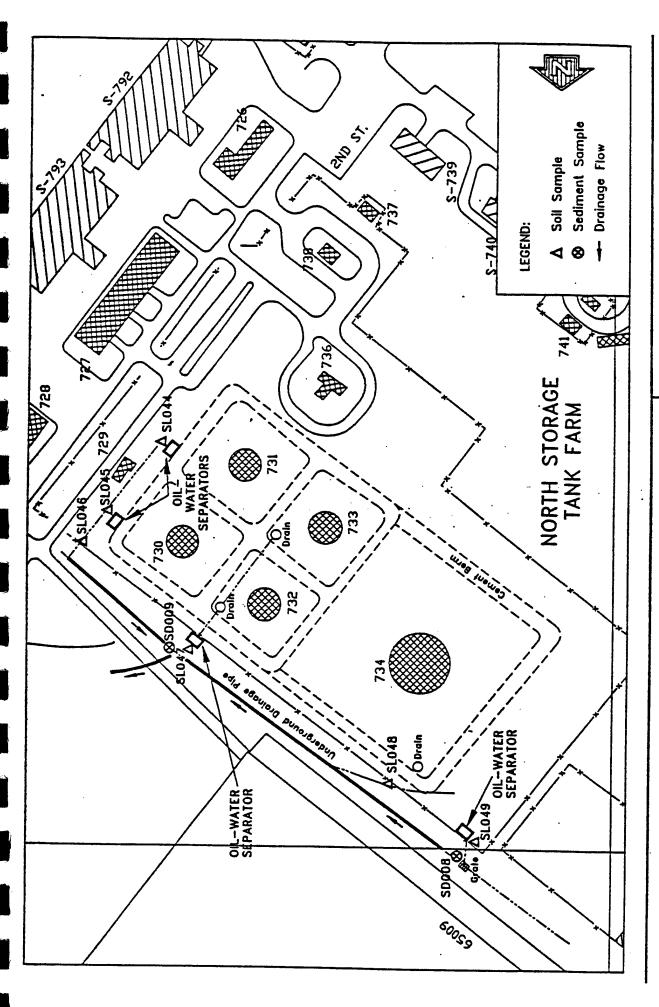
Zone SP- Zone SP is at the North Storage Tank Farm, an aboveground JP-4 jet fuel storage area (see Figure 5 for site map). There have been three known releases from Tank #733 between 1970 and 1979 ranging from 17,000 gallons to 30,000 gallons of JP-4 jet fuel. Figure 6 shows the location of a lithologic cross-section adjacent to Zone SP. Figure 7 shows the cross-section A to A' which indicates that near surface soils include coarse sand and gravel, silt and silty sand, and clay and sandy clay. The water table at the site is located at approximately 10 ft. Soil sample data is not available for the site. A soil gas survey was conducted across the site as shown in Figure 8. The soil gas data indicates highest concentrations adjacent to Tank #732.

Based on the site data for Zone SP the most likely area for the installation of the bioventing well is adjacent to Tank #732. However, site logistics will play an important role in locating the bioventing well and monitoring points. Accessibility to the tank diked area, underground and overhead utilities, and site security may all have an impact on system location.

Project activities-

The following field activities are planned for the bioventing project at Dover AFB. The same procedures will be followed at each site. Additional detail can be found in Section 5.0 of the test plan and technical protocol.

- A small scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. The soil gas survey will be conducted in areas which site data have shown to be the most contaminated. Soil vapor from the candidate site should exhibit high petroleum hydrocarbon concentrations (10,000 ppm or greater), relatively low O₂ concentrations (0 % to 2.0 %), and relatively high CO₂ concentrations (depending on soil type, 2.0 % to 10.0 %, or higher). An uncontaminated background location will also be identified.
- Once the installation sites are located one vent well and three 3-level soil gas monitoring points will be installed in the contaminated location and one vent well will be installed in the background area (one background area will be used for both test sites, if possible). The wells and monitoring points will be installed using a portable drill rig to bore down to just above the water table. Three to four soil samples will be collected for chemical/physical analysis.
- 3- The air permeability test will be conducted in the contaminated test location.



| | DATE: April 1991 |
|-----------------------------------------|---------------------|
| DOVER AIR FORCE BASE DOVER, DELAWARE | SCALE: 0 300 II |

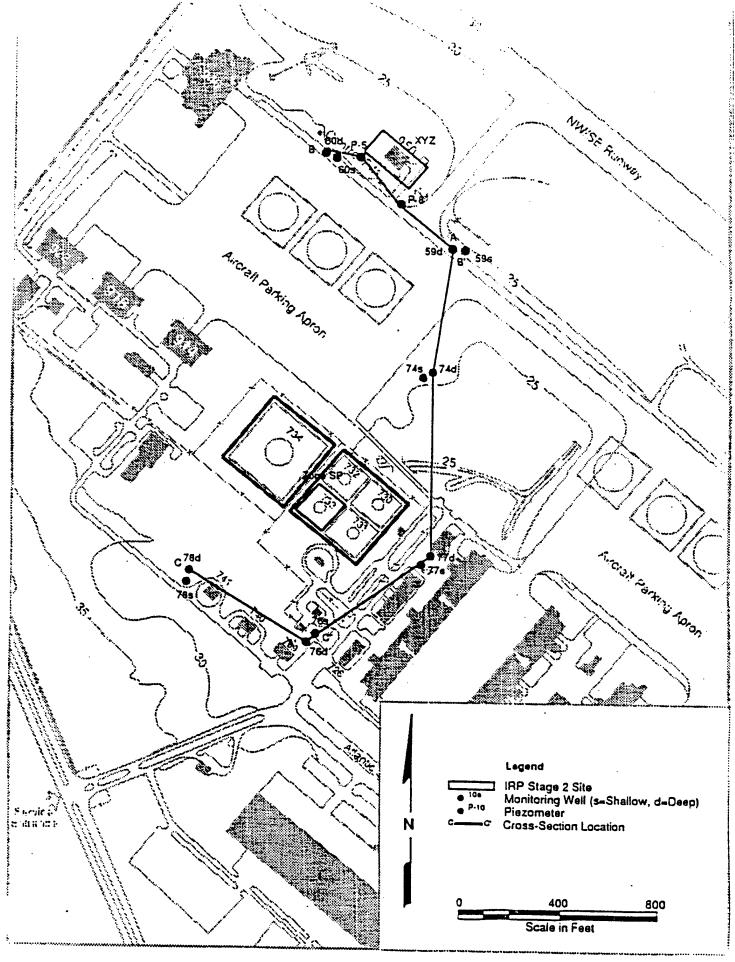


FIGURE 6. CROSS-SECTION LOCATION FOR ZONE SP.

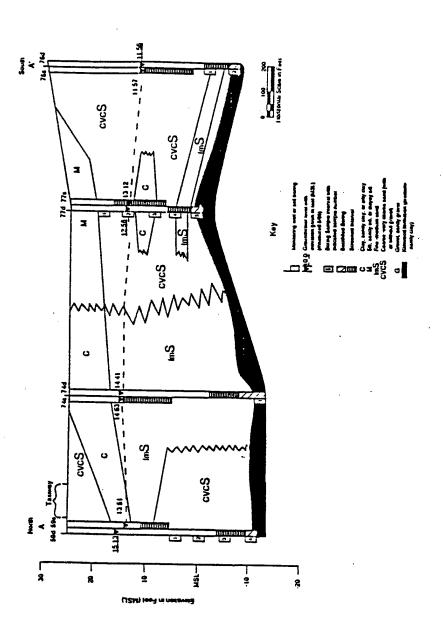


FIGURE 7. ZONE SP CROSS-SECTION A-A'.

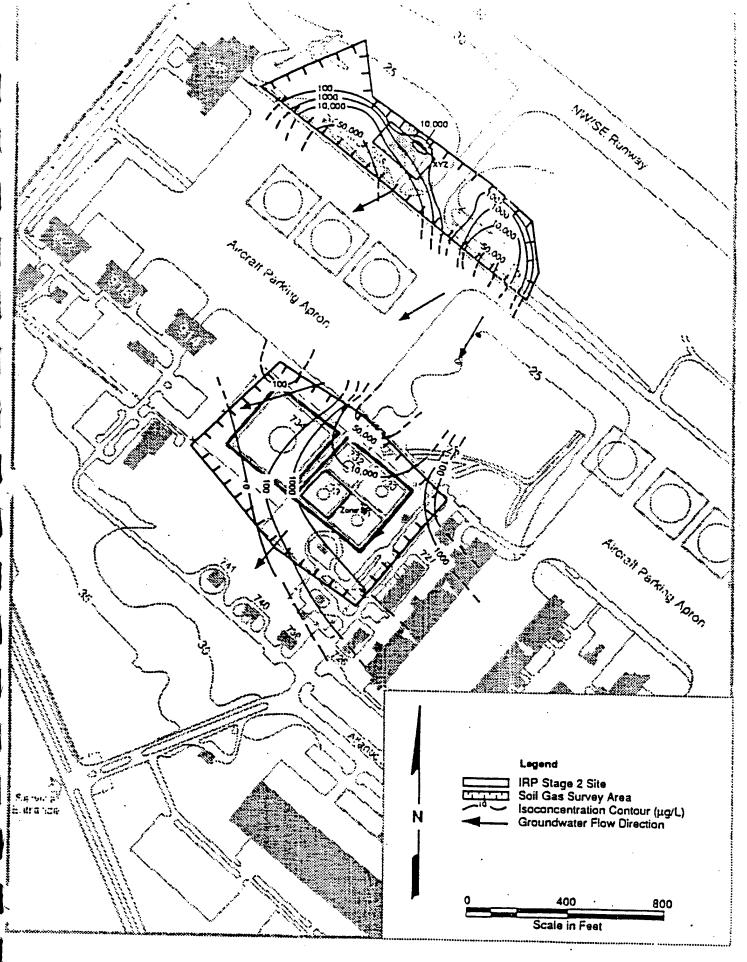


FIGURE 8. ZONE SP: TPH CONCENTRATIONS IN SOIL GAS.

- 4- Following the air permeability test, in situ respiration tests will be conducted in both the contaminated and the background test locations.
- Depending on the results of the air permeability test and the in situ respiration test, a decision will be made whether or not to install a blower system in the contaminated area for the long term bioventing test. If the decision is made to install, the blower will be plumbed to the vent well and bioventing will be started (assuming power is available). Site personnel will be trained for blower operation prior to Battelle leaving the site.
- A report detailing the results of the in situ respiration test and the air permeability test will be provided to the project officer and the base POC.

Schedule-

Field activities at Dover are planned to begin on November 2, 1992. Battelle will have 2 to 3 people on site for approximately 3 weeks.

Base Support-

Dover AFB needs to be able to provide the following:

- Digging permits and utility clearance need to be obtained prior to the initiation of the field work. Underground utilities should be clearly marked to reduce the chance of utility damage or personal injury during soil gas probe and well installation. Battelle will not be able to begin field operations without these clearances.
- Electrical power will need to be easily accessible from the project site. The air permeability test and in situ respiration test can be performed using a gasoline powered electric generator. The operation of the bioventing system will require a permanent 220/110 V power source. If power will not be available immediately after the test is completed the bioventing system will be installed for start-up at a later date.
- Regulatory approval, if any is required, will need to be obtained by the base prior to start-up of the bioventing system. The system will likely be configured for air injection so there will be no point source vapor emission from the system. The wells to be installed will not intersect the apparent water table and no groundwater will be pumped.
- The Air Force will need to provide drums to contain soil cuttings and provide for contaminated soil disposal.

- Base and site clearance will be required for Battelle's site employees. We will furnish you with personal information for each person at least one week prior to starting field operations.

If you have any questions please feel free to call me at (614) 424-6122.

Sincerely,

Jeffrey A. Kittel Researcher Environmental Technology Department

JAK:sh

cc: Major Ross Miller (AFCEE)

Mr. Milton Beck 436 SPTGP/DEV Dover AFB, DE 19902-5516

APPENDIX B

ANALYTICAL REPORT FOR SITE ST-04, THE NORTH STORAGE TANK FARM, AND THE BACKGROUND AREA



AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9211148

Work Order Summary

| Γ | IE! | JT. |
|----------|-----|-----|
| | | ч. |

Mr. Jeff Kittel

Battelle

505 King Ave.

Columbus, OH 43201

BILL TO: Accounts Payable

Engineering Science

1700 Broadway, Ste. 900

Denver, CO 80290

PHONE:

FAX:

614-424-6122

614-424-3667

DATE RECEIVED: 11/23/92 **DATE COMPLETED:** 12/14/92

INVOICE # 8899

P.O. #

PROJECT # G4468-0625

AMOUNT\$: \$1,296.37

| | | | RECEIPT | |
|------------|-----------------------|-------------|------------|----------|
| FRACTION # | <u>NAME</u> | <u>TEST</u> | VAC./PRES. | PRICE |
| 01A | D1-VW-EXHAUST | TO-3 | 0.4 psi | \$120.00 |
| 02A | D1-MPA-11' | TO-3 | 4.0 "Hg | \$120.00 |
| 03A | D1-MPC-11' | TO-3 | 21.5 "Hg | \$120.00 |
| 04A | D1-AMBIENT | TO-3 | 0 "Hg | \$120.00 |
| 05A | D2-VW-3'-8' | TO-3 | Tedlar Bag | \$120.00 |
| 06A | D2-MPA-2.5' | TO-3 | Tedlar Bag | \$120.00 |
| 07A | D2-MPB-2.5' | TO-3 | Tedlar Bag | \$120.00 |
| 08A | D2-MPC-2.5' | TO-3 | Tedlar Bag | \$120.00 |
| 09A | D2-AMBIENT | TO-3 | Tedlar Bag | \$120.00 |
| 10A | D-B6-6'-11' | TO-3 | Tedlar Bag | \$120.00 |
| 10B | D-B6-6'-11' Duplicate | TO-3 | Tedlar Bag | NC |
| 11A | Lab Blank | TO-3 | NA | NC |

1 Liter SUMMA Canister Preparation (4) @ \$10.00 each. \$40.00 Shipping (10/27/92) \$56.37

LAB NARRATIVE:

*Samples 05A-10A were out of hold time due to a FED-X shipping error. Client requested to proceed with analyses.

| CERTIFIED | BY: |
|-----------|-----|
| | |

DATE:

SAMPLE NAME: D1-VW-EXHAUST ID#: 9211148-01A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112508 Dil. Factor: 2000 | | | Date of Collect Date of Analysi | |
|--------------------------------------|--------|--------|------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 2.0 | 6.2 | 65 | 200 |
| Toluene | 2.0 | 7.4 | 100 | 370 |
| Ethyl Benzene | 2.0 | 8.5 | 23 | 98 |
| Total Xylenes | 2.0 | 8.5 | 79 | 350 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112508 Dil. Factor: 2000 | | | Date of Collecti Date of Analysis | |
|----------------------------------------------------------------|--------|--------|--------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 20 | 80 | 83000 | 330000 |
| | | | İ | |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D1-MPA-11' ID#: 9211148-02A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 61125 Dil. Factor: 5 | 18 80 | | Date of Collect Date of Analysi | |
|------------------------------------|----------|--------|------------------------------------|-------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.58 | 1.8 | 55 | 170 |
| Toluene | 0.58 | 2.1 | 71 | 2 60 |
| Ethyl Benzene | 0.58 | 2.5 | 20 | 85 |
| Total Xylenes | 0.58 | 2.5 | 79 | 340 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112518 Dil. Factor: 580 | | | Date of Collect Date of Analysi | |
|----------------------------------------|--------|--------|------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 5.8 | 23 | 34000 | 140000 |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D1-MPC-11' ID#: 9211148-03A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 612010 Dil. Factor: 38 | | | Date of Collect Date of Analysi | |
|--------------------------------------|---------------|---------------|------------------------------------|------------------|
| Compound | MDL (ppmv) | MDL (uG/L) | Amount (ppmv) | Amount (uG/L) |
| Benzene | 0.38 | 1.2 | 74 | 230 |
| Toluene | 0.38 | 1.4 | 16 | 59 |
| Ethyl Benzene | 0.38 | 1.6 | 6.8 | 29 |
| Total Xylenes | 0.38 | 1.6 | 15 | 64 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6120107 Dil. Factor: 380 | | | Date of Collecti Date of Analysi | |
|----------------------------------------|---------------|---------------|-------------------------------------|------------------|
| Compound | MDL (ppmv) | MDL (uG/L) | Amount (ppmv) | Amount (uG/L) |
| TPH* | 3.8 | 15 | 33000 | 13000 |

^{*}TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D1-AMBIENT ID#: 9211148-04A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6120104 Dil. Factor: 2.0 | | | Date of Collecti Date of Analysi | |
|---------------------------------------------------------------|--------|--------|-------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.002 | 0.006 | 1.1 | 3.4 |
| Toluene | 0.002 | 0.007 | 0.28 | 1.0 |
| Ethyl Benzene | 0.002 | 0.008 | 0.091 | 0.39 |
| Total Xylenes | 0.002 | 0.008 | 0.24 | 1.0 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6120104 Dil. Factor: 2.0 | | | Date of Collecti Date of Analysi | |
|----------------------------------------|---------------|---------------|-------------------------------------|------------------|
| Compound | MDL (ppmv) | MDL (uG/L) | Amount (ppmv) | Amount (uG/L) |
| TPH* | 0.020 | 0.080 | 600 | 2400 |

^{*}TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D2-VW-3'-8' ID#: 9211148-05A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112417 Dil. Factor: 5000 | | | Date of Collect Date of Analysi | |
|-----------------------------------------|--------|--------|------------------------------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 5.0 | 16 | Not Detected | Not Detected |
| Toluene | 5.0 | 18 | Not Detected | Not Detected |
| Ethyl Benzene | 5.0 | 21 | Not Detected | Not Detected |
| Total Xylenes | 5.0 | 21 | Not Detected | Not Detected |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112417 Dil. Factor: 5000 | | | Date of Collect Date of Analysi | |
|----------------------------------------------------------------|--------|--------|------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 50 | 200 | 12000 | 48000 |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D2-MPA-2.5' ID#: 9211148-06A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112421 Dil. Factor: 250 | | | Date of Collecti Date of Analysi | |
|----------------------------------------|--------|--------|-------------------------------------|------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.25 | 0.78 | 7.6 | 24 |
| Toluene | 0.25 | 0.92 | 6.7 | 2 5 |
| Ethyl Benzene | 0.25 | 1.1 | 1.7 | 7.2 |
| Total Xylenes | 0.25 | 1.1 | 5.3 | 22 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112421 Dil. Factor: 250 | | | Date of Collect Date of Analysi | |
|-------------------------------------|---------------------|---------------|------------------------------------|--------|
| Compound | MDL (ppmy) | MDL (uG/L) | Amount | Amount |
| ODIT PO CILI | (bbm _A) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 2.5 | 10 | 4800 | 19000 |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D2-MPB-2.5' ID#: 9211148-07A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| | 2507 | | Date of Collect | ion: 11/19/92 |
|---------------|--------|--------|-----------------|---------------|
| Dil. Factor: | 100 | | Date of Analysi | s: 11/25/92 |
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.10 | 0.31 | 5.1 | 16 |
| Toluene | 0.10 | 0.37 | 4.6 | 17 |
| Ethyl Benzene | 0.10 | 0.42 | 2.4 | 10 |
| Total Xylenes | 0.10 | 0.42 | 5.3 | 22 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112507 Dil. Factor: 100 | | ~ | Date of Collecti Date of Analysi | on: 11/19/92 s: 11/25/92 |
|----------------------------------------|---------------|---------------|-------------------------------------|-----------------------------|
| Compound | MDL (ppmy) | MDL (uG/L) | Amount | Amount (uG/L) |
| TPH* | 1.0 | 4.0 | (ppmv) 3800 | 15000 |
| | | | | |

^{*}TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D2-MPC-2.5' ID#: 9211148-08A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112423 Dil. Factor: 50 | | | Date of Collect Date of Analysi | |
|---------------------------------------|--------|--------|------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.050 | 0.16 | 6.3 | 20 |
| Toluene | 0.050 | 0.18 | 5.4 | 20 |
| Ethyl Benzene | 0.050 | 0.21 | 3.2 | 14 |
| Total Xylenes | 0.050 | 0.21 | 8.3 | 35 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112423 Dil. Factor: 50 | | | Date of Collecti Date of Analysi | |
|---------------------------------------|--------|--------|-------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 0.50 | 2.0 | 4000 | 16000 |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D2-AMBIENT ID#: 9211148-09A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112424 Date of Collection: 11/19/92 Dil. Factor: 10 Date of Analysis: 11/24/92 | | | | |
|--------------------------------------------------------------------------------------------|--------|--------|--------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.010 | 0.031 | 0.092 | 0.29 |
| Toluene | 0.010 | 0.037 | 0.069 | 0.25 |
| Ethyl Benzene | 0.010 | 0.042 | Not Detected | Not Detected |
| Total Xylenes | 0.010 | 0.042 | 0.082 | 0.35 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112424 | | | Date of Collecti | on: 11/19/92 |
|--------------------|--------|--------|------------------|--------------|
| Dil. Factor: 10 | | | Date of Analysi | s: 11/24/92 |
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 0.10 | 0.40 | 150 | 600 |
| | | | | |

^{*}TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D-B6-6'-11' ID#: 9211148-10A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112425 DII. Factor: 10 | | | Date of Collecti Date of Analysi | |
|---------------------------------------|--------|--------|-------------------------------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.010 | 0.031 | Not Detected | Not Detected |
| Toluene | 0.010 | 0.037 | Not Detected | Not Detected |
| Ethyl Benzene | 0.010 | 0.042 | Not Detected | Not Detected |
| Total Xylenes | 0.010 | 0.042 | 0.036 | 0.15 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112425 Dil. Factor: 10 | | | Date of Collect Date of Analysi | |
|---------------------------------------|---------------|---------------|------------------------------------|------------------|
| Compound | MDL (ppmv) | MDL (uG/L) | Amount (ppmv) | Amount (uG/L) |
| TPH* | 0.10 | 0.40 | 77 | 310 |

^{*}TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: D-B6-6'-11' Duplicate ID#: 9211148-10B

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112426 Dil. Factor: 10 | | | Date of Collect Date of Analysi | |
|---------------------------------------|--------|--------|------------------------------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.010 | 0.031 | Not Detected | Not Detected |
| Toluene | 0.010 | 0.037 | Not Detected | Not Detected |
| Ethyl Benzene | 0.010 | 0.042 | Not Detected | Not Detected |
| Total Xylenes | 0.010 | 0.042 | 0.034 | 0.14 |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112426 Dil, Factor: 10 | | | Date of Collecti Date of Analysis | |
|---------------------------------------|--------|--------|--------------------------------------|--------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 0.10 | 0.40 | 74 | 300 |
| | | | 1 | |

*TPH referenced to Jet Fuel (MW=156)

SAMPLE NAME: Lab Blank ID#: 9211148-11A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

| File Name: 6112404 Dil. Factor: 1.0 | | | Date of Collect Date of Analysi | |
|----------------------------------------|--------|--------|------------------------------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| Benzene | 0.001 | 0.003 | Not Detected | Not Detected |
| Toluene | 0.001 | 0.004 | Not Detected | Not Detected |
| Ethyl Benzene | 0.001 | 0.004 | Not Detected | Not Detected |
| Total Xylenes | 0.001 | 0.004 | Not Detected | Not Detected |

TOTAL PETROLEUM HYDROCARBONS GC/FID

(Quantitated as Jet Fuel)

| File Name: 6112404 Dil. Factor: 1.0 | | | Date of Collect Date of Analysi | |
|-------------------------------------|--------|--------|------------------------------------|--------------|
| | MDL | MDL | Amount | Amount |
| Compound | (ppmv) | (uG/L) | (ppmv) | (uG/L) |
| TPH* | 0.010 | 0.040 | Not Detected | Not Detected |
| | | | 1 | |

*TPH referenced to Jet Fuel (MW=156)

Container Type: NA



AN ENVIRONMENTAL ANALYTICAL LABORATORY

11325 SUNRISE GOLD CIRCLE, SUITE 'E' RANCHO CORDOVA, CA 95742 (916) 638-9892 • FAX (916) 638-9917

Page__of

CHAIN OF CUSTODY RECORD

| | PROJECT # 6 # | 3 | 6 | COLLECTED BY (Signature) | (Signature) | James E. Hos | fo |
|-----|----------------------------|-------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|------------------------|------------|
| | HEMAHKS (F) | OF CANISTERS | # 7 % / X | O Shorings | | | |
| | | | | 2 192 | | | |
| | FIELD SAMPLE I.D.# | FIELD SAMPLE I.D.# SAMPLING MEDIA (Tenax, Canister etc.) 女 DATE/TIME 1113 11元 | eretc.) 34 DATE/TIME, | 1113 1100 MALYSIS | YSIS | VAC./PRESSURE | LAB I.D. # |
| ~ | DI-YW - Exhaust | CANISTER - 11 | 18 Mary Stall | 18 MONTH BIEX + TOT NOTHERS | - JOURTHES | 154h. 41. | |
| ~ | 11 - MPA - 11' | " | 19 NOV 92 11:00 AM | 10 Am | | V V Ha | |
| w | 11-MPC-11 | 11 | 19 NOV 92 11:00AM | 02A M | | // 21/5/FG | |
| Ħ | 1>1 - AmBIENT | 11 | 19 NOT 92 11:00A | 00Am | | が至って | |
| V | 12-VW-3-8 | TENLAN BAGS -1 | 12 19 NOV 92 12:00 | :00m | | 7 | |
| ی ۰ | 12 - MPA-2.5' | D ", | 19 NOV 92 12:00pm | Wd0 | | | |
| 7 | 1)2-MPB-2.5' | 11 | 19 NOV 92 12:00M |). Moo | | | * |
| حو | DZ-MPC-2.5' | 11 | 19 NOV 92 12:000m | , woo | | | |
| 0 | D2-Amaient | 11 | 19 NOV 92 12:00pm | ~# @ 0 | | | |
| 2 | D- B6-6-111 | 11 | 19 NOV 92 3:00m | → | | | |
| | | | | - | | | |
| | RELINQUISHED BY: DATE/TIME | | RECEIVED BY: DATE/TIME | RELINQUISHED BY: DATE/TIME | 3Y: DATE/TIME | RECEIVED BY: DATE/TIME | ATE/TIME |

| RECEIVED BY: DATE/TIME | ••• | , | | CONDITION | | | 「 |
|--------------------------------|---------------------------------------|---------------|-------------|-----------------------------|-----------------------|---------------|---|
| RELINQUISHED BY: DATE/TIME | | | AB USE ONLY | IME TEMP(°C) | DI-VW-express | 150 DI B 165. | |
| RECEIVED В Ү: ДАТЕ/ТІМЕ | (16/1, OG AT. | 296711 | SO TABOS | SILL # OPENED BY: DATE/TIME | Jack (Och Della | | |
| RELINQUISHED BY: DATE/TIME | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | 1119192500 pm | | SHIPPER NAME | REMABKS AND CRANIC ON | | |



600 BANCROFT WAY BERKELEY, CA 94710 Tel: (415) 548-7970 Fax: (415) 548-7635

Report Date: December 16, 1992

Work Order No.:4537

Client:

Jeff Kittel Battelle 505 King Ave.

Columbus, OH 43201

Date of Sample Receipt: 11/12/92

Your soil samples identified as:

D2-VW-10'-10.5'
D2-VW-7.5-8.0'
D2-VW-3.5-4'
D1-BG-3.5'4.0'
D1-BG-7.0'-7.5
D1-BG-10.0'-10.5'
D1-VW-3.0'-3.5'
D1-VW-7.0'-7.5'
D1-VW-11.0'-11.5'

were analyzed for BTEX by EPA Method 8020, TRPH by EPA Method 418.1, pH, alkalinity, iron, moisture, total Kjeldahl nitrogen, total phosphorus and soil classification.

The analytical reports for the samples listed above are attached.

GC VOLATILES DATA PACKAGE

GC ANALYTICAL REPORT Analytical Method BIEX Aromatic Compounds

Work Order NO.:4537

% Moisture: 32.3

Client ID:D2-VW-10'-10.5'

Matrix:SUIL

Laboratory ID:4537-1

Level:LOW

Date Collected: 11/09/92

Unit:UG/KG

Dilution Factor:

Date Analyzed:11/14/92

Date Confirmed:NA

| 12 | Compound | Result | Reporting Limit |
|------------|-----------------|--------|--------------------|
| | | | |
| | Benzene | ND | 0.9 |
| | Ethyl Benzene | พบ | 0.7 |
| | loluene | 4.0 | 1.0 |
| | Xylenes (total) | ND | 1.3 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: #

GROUP LEADER: Light

GC ANHLYTICAL REPORT Analytical Method BIEX Aromatic Compounds

Work Order NO.:4537

Client ID:D2-VW-7.5/-8.0/

Laboratory ID:4537-2

Date Collected: 11/09/92

Dilution Factor:

% Moisture: 29.52

Matrix:SOIL

Level:MEDIUM

Unit: UG/KG

Date Analozed:11/20/92

Date Confirmed:NA

Compound Result Reporting Limit

 Benzene
 ND
 340.0

 Ethvl Benzene
 510.0
 280.0

 Toluene
 ND
 400.0

Xylenes (total) ND

510.0

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AD

GROUP LEADER: Rim

GC ANALYTICAL REPORT Analytical Method BTEX Aromatic Compounds

Work Order NO.:4557

% Moisture: 12.79

Client ID: D2-VW-5.5/-4/

Matrix:SOIL

Laboratory ID:4557-5

Level:MEDIUH

Date Collected: 11/09/92

Unit:UG/KG

Dilution Factor:

2 Ú

Date Analyzed:11/20/92

Date Confirmed:NA

| | Compound | Result | Reporting Limit |
|------|-----------------|---------------|--------------------|
| ==== | | | |
| | Benzene | ND | 1400.0 |
| | Ethyl Benzene | 58 000 | 1100.0 |
| | Toluene | Nū | 1600.0 |
| | Xylenes (total) | 110000 | 2100.0 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AP

GROUP LEADER : Rusel

and a constraint and any law of the constraint and any and a second and a second and a second and a second and

GC ANALYTICAL REPORT
Headytical Method
BTEX Aromatic Compounds

Work Order NO.:4557

Client ID: D1-BG-3.5/-4.0/

Laboratory ID:4537-4

Date Collected: 11/06/92

Dilution Factor:

% Moisture: 6.14

Matrix:SUIL

Level:LOW

Unit:UG/KG

Date Analyzed:11/14/92

Date Confirmed:NA

| Compound | Result | Reporting Limit |
|-----------------|--------|--------------------|
| Benzene | NŬ | 0.6 |
| Ethyl Benzene | ND | 0.5 |
| Toluene | ND | 0.7 |
| Xylenes (total) | ND | 1.0 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AB

GROUP LEADER : hum

60 ANALYTICAL REPORT Hamalytical Method BTEX Aromatic Compounds

Work Order NO.:4557

% Monsture: 5.42

Cilent ID:01-BG-7.01-7.51

Matrix:50IL

Laboratory ID:4537-5

Level:LOW

Date Collected: 11/06/92

Unit:UG/KG

Dilution Factor:

Date Analyzed:11/14/92

Date Confirmed:NA

| Compound | Result | Reporting Limit |
|-----------------|--------|--------------------|
| | | |
| Benzene | ND | Ü, Ġ |
| Ethyl Benzene | ND | 0.5 |
| Toluëne | 1.5 | 0.7 |
| Xvlenes (total) | ND | 1.0 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

HHALYST: AFT

GROUP LEADER: hur

GC ANALYTICAL REPORT Hnalytical Method BTEX Aromatic Compounds

Work Order NO.:4537

% Moisture: 10.47

Client ID:D1-BG-10.0/-10.5/

Matrix:SOIL

Laboratory ID:4537-6

Level:LUW

Date Collected: 11/06/92

Unit:UG/KG

Dilution Factor: 1

Date Analyzed:11/14/92

Date Confirmed:NA

| Compound | Result | Reporting Limit |
|-----------------|--------|--------------------|
| | | |
| Benzene | ND | 0.7 |
| Ethyl Benzene | ND | 0.6 |
| Toluene | 6.8 | 0.B |
| Xylenes (total) | ND | 1.0 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AS

GROUP LEADER: Assul

GC ANALYTICAL REPORT Analytical Hethod BIEX Aromatic Compounds

Work Order No.:4557

% Moisture: 8.82

Client ID:01-VW-3.04-3.54

1

Matrix:50IL

Laboratory ID:4537-7

Level:LOW

Date Collected: 11/07/92

Unit:UG/KG

Dilution Factor:

Date Analyzed:11/14/92

Date Confirmed:NA

| Compound | Result | Reporting Limit | 0.4 mm 10.7 fts |
|-----------------|--------|--------------------|-----------------|
| Benzene | . ND | Ů. 6 | |
| Ethyl Benzene | ИО | 0.5 | |
| Toluena | 2.1 | Ů, B | |
| Xylenes (total) | Nū | 1.0 | |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AS

GC ANALYTICAL REPORT Analytical Method B[EX Aromatic Compounds

Work Order NO.:4537

Client ID: D1-VW-7.04-7.54

Laboratoru ID:4537-8

Date Collected: 11/07/92

Dilution Factor:

% Moisture: 14.08

Matrix:SUIL

Level:LOW

Unit:UG/KG

Date Analyzed:11/15/92 Date Confirmed:NA

| Compound | Result | Reporting Limit | = |
|-----------------|--------|--------------------|---|
| 0 | N/D | 0. 7 | |
| Benzene | ND | 0.7 | |
| Ethyl Benzene | ND | 0.6 | |
| Toluene | 3,4 | 0.8 | |
| Xylenes (total) | ND | 1.0 | |

ND-Not Detected NA-Not Applicable D-Dilution Factor

HNALYST: AS

GC ANALYTICAL REPORT Hnalytical Hethod BTEX Aromatic Compounds

Work Order NO.:4557

Client ID:D1-VW-11.0/-11.5/

% Moisture: 12.08

Matrix: SOIL

Laboratory ID:4557-9

Level:MEDIUM

Date Collected: 11/07/92

Unit:UG/KG

Dilution Factor: 20

Date Analyzed:11/20/92

Date Confirmed:NA

| Compound | Result | Reporting Limit | 100 000 to 1.0 to 1.0 mg |
|-----------------|--------|--------------------|--------------------------|
| ь. | | | |
| Benzene | 2700.0 | 1400.0 | |
| Ethyl Benzene | 5000.0 | 1100.0 | |
| Toluene | 5200.0 | 1600.0 | |
| Xylenes (total) | 26000 | 2000.0 | |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: AS

GC ANALYTICAL REPORT Analytical Hethod BTEX Aromatic Compounds

Work Order No.:4557

% Moisture:NA

Client ID:METHOD BLANK

Matrix:50IL

Laboratory ID:MWVG2921120B

Level:MEDIUH

Date Collected: NA

Unit:UG/KG

Dilution Factor: 1

Date Analyzed:11/20/92

Date Confirmed:NA

| Compound | Result | Reporting Limit |
|-----------------|--------|--------------------|
| Benzene | ИБ | δÜ. Ü |
| Ethyl Benzene | ИБ | 50.0 |
| Toluene | หม | 70.0 |
| Xylenes (total) | ND | 9 Û . Û |

ND-Not Detected NH-Not Applicable D-Dilution Factor

ANALYST: 40

GC AMALYTICAL REPORT Analytical Hethod BTEX Aromatic Compounds

Work Order NO.:4557

Client ID:METHOD BLANK

Laboratory ID:MSVG2921114B

Date Collected: NA

Dilution Factor:

% Moisture:NA

Matrix:S0IL

Level:LOW

Unit:UG/KG

Date Analyzed:11/14/92

Date Confirmed:NA

| | Result | Reporting Limit |
|-----------------|---------|--------------------|
| Benzene | หบ | 0.6 |
| Ethyl Benzene | HD | 0.5 |
| Toluene | ND | 0.7 |
| Xylenes (total) | ้ ที่มี | ů. 9 |

ND-Not Detected NA-Not Applicable D-Dilution Factor

ANALYST: 26

GROUP LEADER : Knowl

-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY BERKELEY, CA 94710

GC ANALYTICAL REPORT ANALYTICAL REPORT BTEX AROMATIC COMPOUNDS

TRIX: SOIL

DATE:11/14&15/92

| LABORATORY NO. | CLIENT ID | a-a-a-TriFl Toluene | uoro |
|--------------------|----------------|------------------------|------|
| | | | |
| MSVG2921114B | METHOD BLANK | | 92 |
| 4537-1 | D2-VW-10/-10.5 | 5 <i>*</i> | 93 |
| 4537-4 | 01-BG-3.51-4.0 |) (| 76 |
| 4537-5 | D1-BG-7.01-7.5 | ; <i>i</i> | 88 |
| 4537-6 | D1-BG-10.0110. | 5 | 88 |
| 4537-7 | D1-VW-3.01-3.5 | 57 | 88 |
| 4537-8 | D1-VW-7.01-7.5 | (A | 92 |
| 4535-1 | BE18-VMP3-55 | | 88 |
| SSVG2921114A | SPIKE | | 90 |
| SSVG2921114B | SPIKE DUP | | 91 |
| | | | |

-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY BERKELEY, CA 94/10

GC ANALYTICAL REPORT ANALYTICAL REPORT BTEX AROMATIC COMPOUNDS

TRIX: SOIL

DATE:11/20/92

| | | ======================================= |
|----------------|------------------------|-----------------------------------------|
| LABORATORY NO. | CLIENT ID a-a- Tolu | a-TriFluoro ene |
| | | |
| MWVG2921120B | METHOD BLANK | 87 |
| 4537-2 | D2-VW-7.5/-8.0/ | 78 |
| 4537-3 | D2-UW-3.5/-4/ | 73 |
| 4537-9 | D1-VW-11.0′-11.5′ | 74 |

METHUD BLANK SUMMARY

WO # 4537,4533

LAB NAME : ENGINEERING-SCIENCE. INC. DATE ANALYZED :11/14-15/92

AB SAMPLE ID:MSVG2921114B

DATE EXTRACTED : NA

≜ATRIX

:SOIL

INSTRUMENT ID: VGC-2

| LAB SAMPLE ID | CLIENT SAMPLE ID | DATE ANALYZED |
|----------------------|---------------------|------------------|
| SVG2921114B | METHOD BLANK | 11/14/92 |
| 537-1 | D2-VW-10'-10.5' | 11/14/92 |
| 4537-4 | D1-BG-3.5'-4.0' | 11/14/92 |
| ≟ 537−5 | D1-BG-7.01-7.51 | 11/14/92 |
| 537-6 | D1-BG-10.0'-10.5' | 11/14/92 |
| 4537-7 | D1-VW-3.0/-3.5/ | 11/14/92 |
| <u>4</u> 537-8 | D1-VW-7.0/-7.5/ | 11/15/92 |
| 533-1 | BE18-VMP3-55 | 11/15/92 |
| ■ SUG2921114A | SPIKE | 11/14/92 |
| SSVG29211148 | SPIKE DUP | 11/14/92 |

METHOD BLANK SUMMARY

WO # 4537

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :11/20/92

■AB SAMPLE ID:MWVG2921120B

DATE EXTRACTED : NA

MATRIX ≠SOIL

INSTRUMENT ID:UGC-2

| LAB | CLIENT | DATE |
|-------------------------------------------------|--------------------------------------------------------------|----------------------------------------------|
| SAMPLE ID | SAMPLE ID | ANALYZED |
| WUG2921120B 537-2 4537-3 ■ 537-9 | METHOD BLANK D2-VW-7.5'-8.0' D2-VW-3.5'-4' D1-VW-11.0'-11.5' | 11/20/92 11/20/92 11/20/92 11/20/92 |

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS DATA PACKAGE

Work Order NO.: 4537

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical

Method: 418.1

Date Extracted 11/20/92

QC Batch NO.: S92QCB029TPH

Date Analyzed: 11/24/92

| | | ********** | | |
|-------------|-------------------|------------|--------------------|---------------------|
| Sample ID: | Client ID: | Result | Reporting Limit | Percent Moisture |
| | | | | |
| 4537-01 | D2-VW-10'-10.5' | . 22 | 6 | 32.3 |
| 4537-02 | D2-VW-7.5'-8.0' | 8 | 6 | 29.5 |
| 4537-03 | D2-VW-3.5'-4' | 3500 | 5 | 12.8 |
| 4537-04 | D1-BG-3.5'-4.0' | ND | 4 | 6.1 |
| 4537-05 | D1-BG-7.0'-7.5' | ND | 4 | 5.4 |
| 4537-06 | D1-BG-10.0'-10.5' | ND | 4 | 10.5 |
| 4537-07 | D1-VW-3.0'-3.5' | ND | 4 | 8.8 |
| 4537-08 | D1-VW-7.0'-7.5' | 7 | 5 | 14.0 |
| 4537-09 | D1-VW-11.0'-11.5' | 17 | 4 | 12.0 |
| MSTPH921120 | METHOD BLANK | ND | 4 | NA |

NA_ Not Analyzed ND_ Not Detected

ANALYST:

llau-)___

GROUP LEADER:

him/

INORGANICS DATA PACKAGE

Client:

ES-Denver

Work Order:

4537

Project:

AFCEE

Matrix:

Solid

Date

Analyzed

11/20/92

11/23/92

Client's ID: D2-VW-10'

D2-VW-7'

D2-VW-3'

Sample Date:

11/09/92

11/09/92

11/09/92

% Moisture:

Lab ID:

4537.01

4537.02

4537.03

Normal Parameter -----Results-----Method Report Units Limit Alkalinity ND ND ND SM 403(M) 50 mg/Kg CaCO3 11/16/92 32.3 ASTM D2216 Moisture 29.5 12.8 .1 % by wt 5.2 5.3 5.9 EPA 9045 pH Units Hq NA

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable ND- Not Detected

ANALYST:

Don Sleston

Client:

ES-Denver

Work Order:

4537

Project:

AFCEE

Matrix:

Solid

Client's ID:

D1-BG-3'

Sample Date:

11/06/92

% Moisture:

Lab ID:

4537.04

Normal Parameter -----Results-----Method Report Units Date Limit Analyzed Alkalinity ND SM 403(M) 50 mg/Kg CaCO3 11/16/92 6.1 **ASTM D2216** Moisture .1 % by wt 11/20/92 6.1 EPA 9045 pH Units рH NA 11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable ND- Not Detected

ANALYST: Von Gleaton

Client:

ES-Denver

Work Order:

4537

Project:

AFCEE

Matrix:

Solid

Client's ID: D1-BG-7'

D1-BG-10'

Sample Date: 11/06/92

11/06/92

D1-VW-3'

11/07/92

% Moisture:

Lab ID:

4537.05

4537.06

4537.07

| Parameter | | Results | | Method | Normal Report Limit | Units | Date Analyzed |
|------------|-----|---------|-----|------------|---------------------------|-------------|------------------|
| Alkalinity | ND | ND | 58. | SM 403(M) | 50 | mg/Kg CaCO3 | 11/17/92 |
| Moisture | 5.4 | 10.5 | 8.8 | ASTM D2216 | .1 | % by wt | 11/20/92 |
| Ha | 5.3 | 5.5 | 6.6 | EPA 9045 | NA | pH Units | 11/23/92 |

Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable ND- Not Detected

ANALYST:

Client:

ES-Denver

Work Order:

4537

Project:

AFCEE

Matrix:

Solid

Client's ID: D1-VW-7' D1-VW-11'

Sample Date: 11/07/92

11/07/92

% Moisture:

Lab ID:

4537.08

4537.09

| Parameter | | Results | Method | Normal Report Limit | Units | Date Analyzed |
|------------|------|---------|------------|---------------------------|-------------|------------------|
| Alkalinity | ND | ND | SM 403(M) | 50 | mg/Kg CaCO3 | 11/17/92 |
| Moisture | 14.1 | 12.1 | ASTM D2216 | .1 | % by wt | 11/20/92 |
| pН | 4.6 | 4.8 | EPA 9045 | NA | pH Units | 11/23/92 |

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable ND- Not Detected

ANALYST:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client:

ES-Denver

Work Order:

4537

Project:

AFCEE

Matrix:

Solid

Client's ID:

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Blank

Sample Date:
% Moisture:

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Lab ID:

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Normal

| Limit | Date Analyzed |
|----------------------------------------|------------------|
| Alkalinity ND SM 403(M) 50 mg/Kg CaCO3 | 11/16/92 |
| Moisture NA ASTM D2216 .1 % by wt | 11/20/92 |
| pH NA EPA 9045 NA pH Units | 11/23/92 |

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable ND- Not Detected

ANALYST: Von Sleeton

INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order:

4537

% Moisture:

NA

Lab ID of LCS:

Alkalinity:

452.44 LCS

Matrix:

Solid

Units:

mg/Kg CaCO3

| | Date Analyzed | LCS | Conc | % Rec | Advisory % Re | |
|------------|------------------|----------|----------|-------|------------------|------|
| Parameter | LCS | Result | Added | LCS | Low | High |
| | | | | | | |
| Alkalinity | 11/16/92 | 22900.00 | 23650.00 | 97 | 80 | 120 |

ANALYST: Don Sleston Date 11/25/92 REVIEWER: 1883 File:M1QCLCSW

INORGANIC QC SUNNARY - MS and MSD

% Moisture: NA 4537 Work Order: Matriz: Solid Alkalinity Moisture рĦ Lab ID Spk/Dup: Blank Spk 4537.01 4537.01 Units: mg/Kg CaCO3 (Alk) 452.44 451.95 453.49 QC Batch: \$ by wt. (Nois) pH Units (pH) Date -----Results-----RPD RPD -Conc Added-Percent 00 Analyzed Unspiked Sample MS/Sample MSD/Dup Limit MS MSD KS KS/Dup

Recovered MSD Parameter 20 23650.00 23650.00 97 97 0.00 22900.00 22900.00 0 Alkalinity 11/16/92 9 20 11/20/92 32.30 35.17 Moisture 5.16 5.23 1 20 11/23/92

* or N = Outside QC Limit:

Don Sleaton Date 11/25/92 REVIEWER: File: H1QCHSWH

QC Limits for & Rec:

75 -

METALS DATA PACKAGE

Engineering Science - Berkeley Laboratory Inorganics Report CLIENT SAMPLE ID

| THODONITO | ANALVSES | מינאמ | SHEET |
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| b Sampl te Samp eight): | VW10 | 01 |
|-------------------------|---------------------------------|-----|
| b Sampl te Samp eight): | e ID: 4537.0 led : 11/09/ MG/KG | 01 |
| b Sampl te Samp eight): | e ID: 4537.0 led : 11/09/ MG/KG | 01 |
| te Samp | MG/KG | |
| eight): | MG/KG | /92 |
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Engineering Science - Berkeley Laboratory Inorganics Report CLIENT SAMPLE ID

INORGANIC ANALYSES DATA SHEET

| | | | | 1 |
|----------------|----------------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------|
| BERKELEY_L | ABORATORY_ | Contract: AF | CEE | VW7.5 |
| | | | | |
| rater): SOIL | _ | | Lab Samp | ole ID: 4537.02 |
|): LOW_ | | | Date Sam | npled : 11/09/92 |
| _70. | 5 | | | |
| ncentration | Units (ug | /L or mg/kg dry | y weight) |): MG/KG |
| CAS No. | Analyte | Concentration | Q | M |
| 7439-89-6 | Iron | 16200 | _ | _ _ P |
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| | Ca rater): SOIL): LOW70. Incentration | Case No.: 45 (ater): SOIL_): LOW _70.5 (ncentration Units (ug | Case No.: 4537S SAS No.: ater): SOIL_): LOW _70.5 ncentration Units (ug/L or mg/kg dry |): LOW Date San |

| INORGANIC ANALYSES DATA SHEET |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lab Name: E_S_BERKELEY_LABORATORY_ Contract: AFCEE |
| Level (low/med): LOW Date Sampled: 11/09/92 Solids:87.2 CAS No. Analyte Concentration C Q M |
| Lab Sample ID: 4537.03_ Level (low/med): LOW Date Sampled: 11/09/92 Solids:87.2 Concentration Units (ug/L or mg/kg dry weight): MG/KG CAS No. Analyte Concentration C Q M |
| Level (low/med): LOW Date Sampled: 11/09/92 Solids:87.2 Concentration Units (ug/L or mg/kg dry weight): MG/KG CAS No. Analyte Concentration C Q M |
| Concentration Units (ug/L or mg/kg dry weight): MG/KG |
| Concentration Units (ug/L or mg/kg dry weight): MG/KG |
| CAS No. Analyte Concentration C Q M |
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| 7439-89-6 Iron1950 P_ |
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| Name: E_S_ | _BERKELEY_L | ABORATORY_ | Contract: Al | CEE | | BG3.5 |
| Code: ESBL | Ca | se No.: 45 | 37S SAS No.: | | | EDG No.: BG10_ |
| crix (soil/w | ater): SOIL | | | Lab S | ample | ID: 4537.04 |
| vel (low/med |): LOW_ | | | Date | Sampl | ed : 11/06/92 |
| Solids: | _93. | 9 | | | | |
| Co | ncentration | Units (ug | /L or mg/kg dry | y weig | ht): 1 | MG/KG |
| | CAS No. | Analyte | Concentration | Q | М | _ |
| | 7439-89-6 | Iron | 12700 | | P | -; -! _! |
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CLIENT SAMPLE ID

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| | | | | | | 1 | BG7 |
| Lab Name: E_S_ | _BERKELEY_L | ABORATORY_ | Contract: Al | FCE | EE | . | |
| I b Code: ESBL | Ca: | se No.: 45 | 37S SAS No. | : - | | SD | G No.: BG10 |
| Hetrix (soil/w | ater): SOIL | _ | | La | ab Samp | le I | D: 4537.05 |
| Level (low/med |): LOW | _ | | Da | ate Sam | pled | l : 11/06/92 |
| Solids: | _94. | 6 | | | | | |
| Co | ncentration | Units (ug | /L or mg/kg dry | у и | veight) | : MG | ;/KG |
| | CAS No. | Analyte | Concentration | C | Q | M | |
| 1 | 7439-89-6 | Iron | 1970 | _ _ | | P_ | |
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| | - | Inor | ganics Report | | CLIENT SAMPLE ID |
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| ŀ | : | INORGANIC . | ANALYSES DATA S | SHEET | 1 |
| ab Name: E_S_ | _BERKELEY_L | ABORATORY_ | Contract: Al | FCEE | BG10 |
| b Code: ESBL_ | Ca | se No.: 45 | 37S SAS No.: | | SDG No.: BG10 |
| atrix (soil/wa | ater): SOIL | _ | | Lab Samp | ole ID: 4537.06 |
| vel (low/med) | LOW_ | _ | | Date Sam | pled : 11/06/92 |
| Solids: | _89. | 5 | | | |
| Cor | ncentration | Units (ug | /L or mg/kg dry | y weight) | : MG/KG |
| | CAS No. | Analyte | Concentration | | м |
| | 7439-89-6 | Iron | 6850 | | - P_ |
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Engineering Science - Berkeley Laboratory Inorganics Report CLIENT SAMPLE ID

| THODCANTC | AMATVERS | מיתמת | SHEET | |
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| | | THODEANTE | ANALYSES DATA S | ग्ययम | CLIENT SAMPI | E |
|-------------|-------------|---------------|--------------------|---------------|------------------|-------------|
| | • | INURGANIC . | UMUNITAN DUIU E | | l VW3 | |
| Name: E_S_ | _BERKELEY_L | ABORATORY_ | Contract: AF | CEE | | |
| Code: ESBL | Ca: | se No.: 45 | 37S SAS No.: | | SDG No.: BG1 | 10_ |
| rix (soil/w | ater): SOIL | _ | | Lab Sam | ple ID: 4537.07 | 7 |
| el (low/med |): LOW_ | | | Date Sa | ampled : 11/07/9 | 92 |
| olids: | _91. | 2 | | | | |
| Co | ncentration | Units (ug | /L or mg/kg dry | y weight | e): MG/KG | |
| | CAS No. | Analyte | Concentration | C Q | м | |
| | 7439-89-6 | Iron | 7420 | | P | |
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| | ı | NORGANIC . | ANALYSES DATA S | SHEET | CLIENT SAMPLE I |
|-----------------|------------|------------|-----------------|----------------------------------------------|-------------------|
| | _ | | | | VW7 |
| ab Name: E_S_B | ERKELEY_LA | BORATORY_ | Contract: Al | CEE | |
| ab Code: ESBL | Cas | e No.: 45 | 37S SAS No. | <u></u> | _ SDG No.: BG10_ |
| atrix (soil/wat | er): SOIL_ | | | Lab Sa | mple ID: 4537.08 |
| evel (low/med): | LOW | - | | Date Sa | ampled : 11/07/92 |
| Solids: | _85.9 | • | | | |
| Conc | entration | Units (ug | /L or mg/kg dry | y weigh | t): MG/KG |
| , <u> </u> | | | 1 | | |
| ļc | AS No. | Analyte | Concentration | ICI Q | M |
| 7 | 439-89-6 | Iron | 3230 | - | P_ |
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CLIENT SAMPLE ID

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| | | | <u> </u> | | | VW11 | |
| | | | Contract: AF | | | | |
| Code: ESBL | Ca: | se No.: 45 | 37S SAS No.: | | SD | G No.: B | G10_ |
| rix (soil/w | ater): SOIL | <u> </u> | | Lab Sa | ample I | D: 4537. | 09 <u> </u> |
| vel (low/med |): LOW_ | _ | | Date S | Sampled | : 11/07 | /92 |
| Solids: | 87. | 9 | | | | | |
| Co | ncentration | Units (ug | /L or mg/kg dry | y weigl | ht): MG | /KG | |
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| | İ | 1 | Concentration | 1 1 | | | |
| | 7439-89-6 | Iron | 3450 | | P | | |
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INORGANIC ANALYSES DATA SHEET

| CLIENT | SAMPLE | ID |
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| trix (soli/water): borz_ | SDG No.: BG10 ample ID: PBK 482. Sampled : 12/07/92 (ht): MG/KG |
|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| trix (soil/water): SOIL | ample ID: PBK 482. Sampled : 12/07/92 (ht): MG/KG |
| vel (low/med): LOW Date Solids: 100.0 Concentration Units (ug/L or mg/kg dry weig | Sampled : 12/07/92 (ht): MG/KG |
| Vel (low/med): LOW Date Solids: 100.0 Concentration Units (ug/L or mg/kg dry weig CAS No. Analyte Concentration C Q | ht): MG/KG |
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| 7439-89-6 Iron4.6 U | in-i |
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Level (low/med): LOW___

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| ab | Name: | E_SBERKELEY | _LABORATORY_ | Contract: AFCEE | i | i |
| ab | Code: | ESBL | Case No.: 45378 | S_ SAS No.: | SDG No.: B | G10 |

Concentration Units: ug/L

trix (soil/water): SOIL_

| | 11 | Serial | 1 | 1 8 1 | 1 | 1 |
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| | Initial Sample | Dilution | - 1 | Differ- | 1 | 1 |
| Analyte | Result (I) C | Result (S) | ci | ence | ĮQ | 1 |
| Iron | 67722.80 <u> </u> | 73293.24 | | 8.2 | 1- | P_ |
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Engineering Science - Berkeley Laboratory

| Method Det | tection | Limits | (Annually) |
|------------|---------|--------|------------|
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| Lab Name: 1 | E_SBERKEI | LEY_LABORA | TORY_ | Contract | AFCEE | | • |
|-------------|---------------|--------------------------|--------------|-----------|---------------|-------------|--------------|
| b Code: 1 | ESBL | Case No.: | 4537S_ | SAS No.: | | s | DG No.: BG10 |
| ICP ID Numl | ber: | TJA_61_ | м | Date: | 08/31/92 | 2 | |
| ame AA II | D Number : | | | Matrix: S | soir- | • | |
| Marnace AA | ID Number | : | | (ug/L in | 1.00g to | 100m | l digestate) |
| | Analyte Iron | Wave-length (nm) 271.44 | ground | | MDL (ug/L) | | |
| Comments: | | | | | | | |
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ILMO2.

Engineering Science - Berkeley Laboratory Inorganics Report

PREPARATION LOG

| ina h | Name. | F. | S | BERKELEY | LABORATORY_ | Contract: | AFCEE |
|--------------|-------|----|---|----------|--------------|-----------|---------|
| $\alpha \nu$ | Name: | 11 | | _runnur_ | _mmbowmtowt_ | concrace. | 111 011 |

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: ____ SDG No.:BG10__

ethod: P_

| EPA | 1 | | |
|--------|-------------|--------|--------|
| Sample | Preparation | Weight | Volume |
| No. | Date | (gram) | (mL) |
| İ | j | ` _ | ` |
| BG10 | 12/07/92 | 1.21 | 100_ |
| BG3.5 | 12/07/92 | 1.22 | 100 |
| BG7 | 12/07/92 | 1.09 | 100 |
| LCSS | 12/07/92 | 1.00 | 100 |
| LCSSD | 1_12/07/92 | 1.00 | 100 |
| PBLANK | 12/07/92 | 1.00 | 100 |
| TIMPA5 | 12/07/92 | 1.36 | 100 |
| TIMPB5 | [_12/07/92 | 1.12 | 100 |
| TIVW5 | _12/07/92 | 1.12 | 100 |
| VW10 | _12/07/92 | 1.24 | 100 |
| VW11 | _12/07/92 | 1.14 | 100 |
| VW3 | 1_12/07/92 | 1.24 | 100 |
| VW3.5 | 1_12/07/92 | 1.04 | 100 |
| VW7 | _12/07/92 | 1.19 | 100 |
| VW7.5 | 1_12/07/92 | 1.14 | 100 |
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FORM XIII - IN

ILMO2.1

Engineering Science - Berkeley Laboratory Inorganics Report

ANALYSIS RUN LOG

ab Name: E_S_BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: ____ SDG No.:BG10__

nstrument ID Number: TJA 61 M_

Method: P_

Start Date: 12/08/92

End Date: 12/08/92

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| STD1 | 1.00 | 1254 | | | X | | _ | _1 | _1 | _ | _1 | _ | _ | _ | | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _1 | _1_1 |
| TSTD2 | 1.00 | 1258 | | | X | _ | _ | _1 | _ | _ | | _ | _ | | _ | | _ | _ | _ | _ | _ | _ | _ | _ | _ | _1 | _1_1 |
| LSTD3 | 1.00 | 1303 | | | X | _ | _1 | | _1 | | _ | _ | _ | _ | _ | _ | _1 | _ | _ | _ | _ | _1 | _ | _ | _ | _ | _1_1 |
| STD4 | 1.00 | 1308 | | | X | _ | _ | | | | _ | | | _ | | _ | _1 | _ | _ | _ | _ | _ | _ | _ | _ | _ | _1_1 |
| PICV | 1.00 | 1312 | | | X | _ | _ | _1 | _ | | _ | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | | _ | _ | _1 | _1_1 |
| ICB | 1.00 | 1317 | | | X | | _ | | _ | _ | _ | _ | _ | _ | | _ | _ | _ | _1 | | _ | _1 | | _ | | _ | _ _ |
| ICSA | 1.00 | 1321 | | | X | _ | _ | | _ | _ | _ | _ | _ | _ | | _ | _ | _ | _ | _1 | _ | _1 | | _ | _ | _ | _1_1 |
| ICSAB | 1.00 | 1326 | | | X | _ | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _ | _ _ |
| CRI | 1.00 | 1331 | | | .1 | _ | _ | _ | | _ | _ | _ | _ | _ | | | _ | _ | | | _ | | _ | _ | | _ | _ _ |
| ZZZZZZZ | | 1335 | | | _ _ | _ | _ | | _ | | _ | _ | | _ | _ | | _1 | _ | I | _ | | _ | _ | | | _ | _ _ |
| PBLANK | 1.00 | 1340 | l | | X | _ | _1 | _ | | | | _ | _ | | | | _! | _ | _ | _ | _ | _ | _ | _ | _ | _1 | _1_1 |
| TLCSS | 1.00 | 1344 | | | X | - | _1 | _ | _ | | | _ | | | | _ | _1 | _ | | | _ | _1 | _ | _ | _ | _1 | _1_1 |
| LLCSSD | 1.00 | 1349 | | | X | | _1 | _ | | I | _ | _ | _ | _ | | | _ | _ | _ | _ | | _ | | | _ | _1 | _1_1 |
| VW10 | 1.00 | 1354 | <u> </u> | | X | _ | _ | _ | _ | _ | | | _ | _ | | _ | _ | _ | | | _ | | | | _ | _1 | _1_1 |
| WVW10L | 1.00 | 1358 | | | X | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _1 | | _ | | _ | _1 | _ | _ | _ | _ | _1_1 |
| VW7.5 | 1.00 | 1403 | | | X | | | | | | _ | _ | _ | _ | _ | _ | | | _ | | | _ | _ | _ | _ | | _1_1 |
| ccv | | 1408 | l | | X | | _ | _ | _ | | _ | _ | _ | | _ | _ | _ | _1 | _ | _ | _ | _ | _ | _1 | _ | _1 | _1_1 |
| CCB | 1.00 | 1412 | | | X | | | _ | | _ | _ | _ | _ | _ | _ | _ | _1 | ! | | | | _ | | _ | _ | _ | _1_1 |
| [VW3.5 | 1.00 | 1417 | l | | X | _ | | _ | _ | _ | _ | | _ | | _ | _ | _1 | | 1 | | _ | _ | _ | _ | _ | _ | _1_1 |
| ≟ BG3.5 | 1.00 | 1421 | l | | X | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _ | _ | _ | _ | _ | _ | _1_1 |
| BG7 | 1.00 | 1426 | l | | X | _ | _ | _ | _ | _ | _ | _ | | _ | | _ | _ | _/ | _1 | _ | | | _ | _ | _ | _1 | _1_1 |
| TBG10 | 1.00 | 1431 | l | | X | | _ | _ | _ | | _ | | _ | _ | _ | _ | _ | | _1 | _ | _ | _ | _ | | _ | _1 | _1_1 |
| TAM3 | 1.00 | 1435 | l | | X | _ | _ | _ | _ | _ | | | | _ | | | _ | _1 | _ | _ | _ | _ | | _ | _ | _1 | _1_1 |
| VW7 | 1.00 | 1440 | l | | X | _ | | | _ | _ | _ | | _ | _ | _ | _ | _1 | _1 | | _ | _ | _ | _ | _ | _ | | _1_1 |
| P VW11 | 1.00 | 1445 | | | X | _ | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _1 | _1 | _ | _ | _ | _ | _ | _ | | _1_1 |
| TIVW5 | 1.00 | 1449 | l | | X | _ | | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _1 | _ | _ | _ | _ | _ | _ | _ | _1 | _1_1 |
| TIMPA5 | 1.00 | 1454 | | | X | _ | | _ | | _ | | | _ | _ | | _ | _1 | _ | _1 | I | _ | | _ | _ | | | _1_1 |
| TIMPB5 | 1.00 | 1458 | l | | X | | _ | _ | _ | _ | ا_ ا | | _ | _ | _ | _ | | | | _ | _ | | _ | _ | _ | | _1_1 |
| Tccv | 1.00 | 1503 | l | | X | | _ | _ | _ | _ | _ | _ | _ | _ | | _ | 1 | | | _ | _ | _ | _ | _ | _ | _ | _1_1 |
| iccb | 1.00 | 1508 | l | | _ X | | _ | | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | | _ | _ | _ | _ | _ | | _1_1 |
| ICSA | 1.00 | 1512 | l | | X | | _ | | <u> </u> | _ | _ | _ | | _ | | 1_1 | | _ | | _ | _ | _ | _ | _ | _ | _ | _ _ |
| TICSAB | 1.00 | 1517 | | | X | I _ | <u>_</u> | | _ | _ | _ | _ | _ | _ | | _ | _ | _ | | _ | _ | _ | <u> _</u> | _ | _ | _ | _ _ |
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Engineering Science - Berkeley Laboratory Inorganics Report

ANALYSIS RUN LOG

| ab | Name: | E S | BERKELEY | LABORATORY | |
|----|-------|-----|----------|------------|--|
| | | | | | |

Contract: AFCEE____

Lab Code: ESBL___ Case No.: 4537S_ SAS No.: ____ SDG No.:BG10___

nstrument ID Number: TJA 61 M_

Method: P_

Start Date: 12/08/92

End Date: 12/08/92

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| ccvi | 1.00 | 1526 | | | X | _ | _ | | | i | i | _i | _i | | | | | | | | | | i | _i | \equiv i | | _i |
| CCB | 1.00 | 1531 | | | X | | | | | | _i | Ξi | | i | | | | | | | | | | | $\exists i$ | | _i |
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ILMO2.1

TOTAL PHOSPHORUS TOTAL KJELDAHL NITROGEN SOIL CLASSIFICATION DATA PACKAGE



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc. 600 Bancroft Way Berkeley, CA 94710 Attention: Tom Paulson

Client Project ID: WO #4537 Sample Descript:

Soil

Total Phosphorus

Analysis for: First Sample #:

211-2219

Sampled:

11/6-9/92

Received:

Nov 13, 1992

Analyzed: Nov 20, 23, 1992

Reported: Dec 8, 1992

LABORATORY ANALYSIS FOR:

Total Phosphorus

| Sample Number | Sample Description | Detection Limit mg/kg | Sample Result mg/kg |
|------------------|-----------------------|--------------------------|---------------------------|
| 211-2219 | D2-WW-10 | 10 | 140 |
| 211-2220 | D2-W-7 | 10 | 110 |
| 211-2221 | D2-W-3 | 10 | 64 |
| 211-2222 | D1-BG-3 | 10 | 330 |
| 211-2223 | D1-BG-7 | 10 | 110 |
| 211-2224 | D1-BG-10 | 10 | 230 |
| 211-2225 | D1-W-3 | 10 | 310 |
| 211-2226 | D1-W-7 | 10 | 240 |
| 211-2227 | D1-VW-11 | 10 | 260 |
| - | Method Blank | 10 | N.D. |

THIS REPORT HAS BEEN APPROVED AND REVIEWED BY

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Please Note:

Analysis results reported on a dry weight basis.

JOE 18 Tod Granicher Project Manager

2112219.ENG <11>



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc. 600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537

Sampled: Received:

11/6-9/92 Nov 13, 1992

600 Bancroft Way Berkeley, CA 94710 Sample Descript: Analysis for:

Total Kjeldahl Nitrogen

Analyzed:

Nov 23, 1992

First Sample #:

211-2219

Soil

Reported:

Dec 8, 1992

LABORATORY ANALYSIS FOR:

Total Kjeldahl Nitrogen

| Sample Number | Sample Description | Detection Limit mg/kg | Sample Result mg/kg |
|------------------|-----------------------|--------------------------|---------------------------|
| 211-2219 | D2-VW-10 | 20 | 700 |
| 211-2220 | D2-VW-7 | 20 | 460 |
| 211-2221 | D2-VW-3 | 20 | 84 |
| 211-2222 | D1-BG-3 | 20 | 210 |
| 211-2223 | D1-BG-7 | 20 | N.D. |
| 211-2224 | D1-BG-10 | 20 | 35 |
| 211-2225 | D1-VW-3 | 20 | 78 |
| 211-2226 | D1-VW-7 | 20 | 36 |
| 211-2227 | D1-VW-11 | 20 | 31 |
| - | Method Blank | 20 | N.D. |

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

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Tod Granicher Project Manager Please Note:

Analysis results reported on a dry weight basis.

2112219.ENG <12>



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc. 600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537

Sample Descript: Soil

Percent Moisture

Analysis for: First Sample #: 211-2219 Sampled:

Nov 6-9, 1992

Received: Nov 13, 1992

Analyzed: Nov 18, 1992 Reported: Dec 8, 1992

LABORATORY ANALYSIS FOR:

Percent Moisture

| Sample Number | Sample Description | Detection Limit % | Sample Result % |
|------------------|-----------------------|----------------------|-----------------------|
| 211-2219 | D2-VW-10 | 0.010 | 29 |
| 211-2220 | D2-VW-7 | 0.010 | 26 |
| 211-2221 | D2-VW-3 | 0.010 | 13 |
| 211-2222 | D1-BG-3 | 0.010 | 14 |
| 211-2223 | D1-BG-7 | 0.010 | 4.0 |
| 211-2224 | D1-BG-10 | 0.010 | 7.0 |
| 211-2225 | D1-VW-3 | 0.010 | 13 |
| 211-2226 | D1-W-7 | 0.010 | 9.0 |
| 211-2227 | D1-VW-11 | 0.010 | 15 |

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tous

Tod Granicher Project Manager

2112219.ENG <10>



Engineering Science, Inc.

600 Bancroft Way Berkeley, CA 94710

Attention: Tom Paulson

Client Project ID: WO #4537

QC Sample Group: 2112219-27

Reported: Dec 8, 1992

QUALITY CONTROL DATA REPORT

| ANALYTE | Phosphorus | Percent Moisture | Total | |
|------------------|--------------|------------------|------------------|---|
| | | <u></u> | Kjeldahl | |
| | | | Nitrogen | |
| Method: | EPA 365.3 | EPA 160.3 | EPA 351.4 | |
| Analyst: | K. Follett | Y. Arteaga | G. Kern | |
| Reporting Units: | mg/kg | % | mg/kg | |
| Date Analyzed: | Nov 20, 1992 | Nov 18, 1992 | Nov 23, 1992 | |
| QC Sample #: | 211-2215 | 211-1615 | 211-2223 | • |
| Sample Conc.: | 37 | 24 | N.D. | |
| Spike Conc. | | | • | |
| Added: | 100 | N.A. | 4000 | |
| Conc. Matrix | | | 2400 | |
| Spike: | 150 | N.A. | 3400 | |
| Matrix Spike | | | | · |
| % Recovery: | 113 | N.A. | 85 | |
| Conc. Matrix | | | | |
| Spike Dup.: | 130 | 27 | 3700 | |
| Matrix Spike | | | | • |
| `Duplicate | 00 | A1 A | | |
| % Recovery: | 93 | N.A. | 93 | |
| Relative | | | | |
| % Difference: | 14 | 12 | [,] 8.5 | |

SEQUOIA ANALYTICAL

JODIE Tod Granicher

Project Manager

x 100 Conc. of M.S. - Conc. of Sample % Recovery: Spike Conc. Added Conc. of M.S. - Conc. of M.S.D. x 100 Relative % Difference: (Conc. of M.S. + Conc. of M.S.D.) / 2

2112219.ENG <13>



Engineering Science, Inc.

Client Project ID:

WO #4537

Sampled:

Nov 9, 1992

600 Bancroft Way

Sample Descript:

Soil, D2-VW-10

Received:

Nov 13, 1992

Berkeley, CA 94710

Method of Analysis: ASTM D422-63

Analyzed:

Nov 24, 1992

Attention: Tom Paulson

Lab Number:

211-2219

Reported:

Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

174.65 8.24 95.28

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0 IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 0.0 | 0.0 | 0.0 | 100 |
| No. 4 | 4.00 | 2.29 | 2.29 | 97.71 |
| No. 10 | 4.24 | 2.43 | 4.72 | 95.28 |
| | | | | |
| PAN | 0.0 | | <u> </u> | |
| TOTAL | 8.24 | | | |
| IOIAL | 1 0.24 | 1 | | |

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | °C | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 20 | 54 | 50 | 8.1 | 0.027 |
| 5 | 20 | 52 | 48 | 8.4 | 0.018 |
| 10 | 20 | 50 | 46 | 8.8 | 0.013 |
| 15 | 20 | 48 | 44 | 9.1 | 0.011 |
| 25 | 20 | 45 | 41 | 9.6 | 0.0085 |
| 40 | 20 | 42 | 38 | 10.1 | 0.0069 |
| 60 | 20 | 41 | 37 | 10.2 | 0.0056 |
| 90 | 20 | 38 | 34 | 10.7 | 0.0047 |
| 120 | 20 | 37 | 33 | 10.9 | 0.0041 |
| 1440 | 20 | 30 | 26 | 12 | 0.0012 |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G): SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | FORMULA |
|---------|---------|
| 0.965 | R = H - |
| 2.65 | S = K[|
| 3 | P = (R |
| 1 | W = |
| 0.01365 | J = 1 |

S: E-F SQRT(L/T)] /W) 100 (J·100)/C D·G

SEQUOIA ANALYTICAL

John Tod Granicher Project Manager



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710

Attention: Tom Paulson

Client Project ID:

WO #4537 Sample Descript: Soil, D2-VW-7

Method of Analysis: ASTM D422-63

Lab Number:

211-2220

Sampled:

Nov 9, 1992

Received:

Nov 13, 1992 Nov 30, 1992

Analyzed: Reported:

Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

| 320.36 | - |
|--------|---|
| 0.0 | _ |
| 100 | |

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0 IDEALTOTAL = (B)

| | | WEIGHT | | CUMULATIVE | CUMULATIVE |
|---|------------|-------------|------------|------------|------------|
| | | | | | |
| | SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1 | 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| | 3/8 in. | 0.0 | 0.0 | 0.0 | 100 |
| | No. 4 | 0.0 | 0.0 | 0.0 | 100 |
| | No. 10 | 0.0 | 0.0 | 0.0 | 100 |
| | | | | | |
| | | | | | |
| • | PAN | 0.0 | | | |
| | TOTAL | 0.0 | | | |

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 55 | 51 | 7.9 | 0.028 |
| 5 | 18 | 54 | 50 | 8.1 | 0.018 |
| 10 | 18 | 51 | 47 | 8.6 | 0.013 |
| 15 | 18 | 49 | 45 | 8.9 | 0.011 |
| 25 | 18 | 47 | 43 | 9.2 | 0.0085 |
| 40 | 18 | 45 | 41 | 9.6 | 0.0069 |
| 60 | 18 | 42 | 38 | 10.1 | 0.0057 |
| 90 | 18 | 40 | 36 | 10.4 | 0.0048 |
| 120 | 18 | 39 | 35 | 10.6 | 0.0042 |
| 1440 | 18 | 32 | 28 | 11.7 | 0.0013 |

| (P) 81 80 75 72 68 65 60 57 56 | % SUSPENDED |
|----------------------------------|-------------|
| 80 75 72 68 65 60 | (P) |
| 75 72 68 65 60 57 | |
| 72 68 65 60 57 | |
| 68 65 60 57 | 75 |
| 65 60 57 | 72 |
| 60 57 | |
| 57 | |
| 57 56 45 | 60 |
| 56 45 | 57 |
| 45 | 56 |
| | 45 |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):

SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | FORMU |
|-------|-------|
| 0.967 | R = 1 |
| 2.65 | ີ |
| 3 | 7 P= |
| 1 | ~ w |

0.01399

JLAS: H-E-F

K[SQRT(L/T)]

(R/W) 100° $W = (J \cdot 100) / C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

Tooll

Tod Granicher Project Manager

2112219.ENG <2>



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

Attention: Tom Paulson

600 Bancroft Way Berkeley, CA 94710 Client Project ID:

WO #4537 Sample Descript: Soil, D2-VW-3

Sampled: Received:

Nov 9, 1992 Nov 13, 1992

Method of Analysis: ASTM D422-63 Lab Number:

211-2221

Analyzed: Reported:

Nov 30, 1992 Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

| 319.56 | |
|--------|--|
| 32.48 | |
| 88.84 | |

SIEVE TEST FOR **WEIGHT RETAINED** IN NO. 10 SIEVE

IDEAL PAN = 0.0IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 0.0 | 0.0 | 0.0 | 100 |
| No. 4 | 6.89 | 2.16 | 2.16 | 97.84 |
| No. 10 | 25.59 | 8.01 | 10.17 | 89.83 |
| - | | | | |
| PAN | 0.0 | | <u> </u> | |

TOTAL 32.48

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | °C | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 17 | 13 | 14.2 | 0.037 |
| 5 | 18 | 14 | 10 | 14.7 | 0.024 |
| 10 | 18 | 13 | 9 | 14.8 | 0.017 |
| 15 | 18 | 12 | 8 | 15 | 0.014 |
| 25 | 18 | 12 | 8 | 15 | 0.011 |
| 40 | 18 | 11 | 7 | 15.2 | 0.0086 |
| 60 | 18 | 11 | 7 | 15.2 | 0.007 |
| 90 | 18 | 10 | 6 | 15.3 | 0.0058 |
| 120 | 18 | 10 | 6 | 15.3 | 0.005 |
| 1440 | 18 | 9 | 5 | 15.5 | 0.0015 |

| % SUSPENDED |
|-------------|
| (P) |
| 18 |
| 14 |
| 13 |
| 11 |
| 11 |
| 9.8 |
| 9.8 |
| 8.4 |
| 8.4 |
| 7 |
| |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G): SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | IFORMULAS: |
|---------|-------------------------|
| 0.991 | R = H - E - F |
| 2.65 | S = K[SQRT(L/T)] |
| 3 | P = (R/W) 100 |
| 1 | $W = (J \cdot 100) / C$ |
| 0.01399 | J = D·G |

SEQUOIA ANALYTICAL

JEDJE Tod Granicher

Project Manager



680 Chesapeake Drive . Redwood City, CA 94063 01? (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537/ Sample Descript:

Soil, D2 BG-3 Method of Analysis: ASTM D422-63

211-2222 Lab Number:

Sampled:

Nov 6, 1992 Nov 13, 1992

Received: Analyzed:

Nov 30, 1992

Reported: Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

230.58 8.6 96.27

SIEVE TEST FOR **WEIGHT RETAINED** IN NO. 10 SIEVE

IDEAL PAN = 0.0 IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 0.0 | 0.0 | 0.0 | 100 |
| No. 4 | 0.0 | 0.0 | 0.0 | 100 |
| No. 10 | 8.60 | 3.73 | 3.73 | 96.27 |
| | | | | |
| PAN | 0.0 | | <u> </u> | |
| TOTAL | 8.60 | | | |

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | °C | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 38 | 34 | 10.7 | 0.032 |
| 5 | 18 | 33 | 29 | 11.5 | 0.021 |
| 10 | 18 | 28 | 24 | 12.4 | 0.015 |
| 15 | 18 | 27 | 23 | 12.5 | 0.013 |
| 25 | 18 | 25 | 21 | 12.9 | 0.010 |
| 40 | - 18 | 22 | 18 | 13.3 | 0.0081 |
| 60 | 18 | 21 | 17 | 13.5 | 0.0066 |
| 90 | 18 | 20 | 16 | 13.7 | 0.0055 |
| 120 | 18 | 19 | 15 | 13.8 | 0.0047 |
| 1440 | 18 | 16 | 12 | 14.3 | 0.0014 |

| % SUSPENDED |
|-------------|
| (P) 51 |
| 51 |
| 44 |
| 36 |
| 35 |
| 32 |
| 27 |
| 26 |
| 24 |
| 23 |
| 18 |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G): SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | I |
|---------|---|
| 0.987 | I |
| 2.65 | l |
| 3 | ı |
| 1 | l |
| 0.01399 | l |

FORMULAS: R = H - E - F

S = K[SQRT(L/T)]

P = (R/W) 100

 $W = (J \cdot 100) / C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

SLOOT

Tod Granicher **Project Manager**

2112219.ENG <4>



Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710

Attention: Tom Paulson

Client Project ID:

WO #4537 Sample Descript:

Soil, D1-BG-7 Method of Analysis: ASTM D422-63

Lab Number: 211-2223 Sampled:

Nov 6, 1992

Received: Nov 13, 1992 Analyzed:

Dec 1, 1992 Reported: Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

277.64 38.77 86.04

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0 IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 1.0 | 100 |
| 3/8 in. | 3.29 | 1.18 | 1.18 | 98.82 |
| No. 4 | 15.17 | 5.46 | 6.64 | 93.36 |
| No. 10 | 20.31 | 7.32 | 13.96 | 86.04 |
| | | | | |
| | | | | |
| PAN | 0.0 | | | |

TOTAL 38.77

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | ಌ | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 10 | 6 | 15.3 | 0.039 |
| 5 | 18 | 10 | 6 | 15.3 | 0.024 |
| 10 | 18 | 10 | 6 | 15.3 | 0.017 |
| 15 | 18 | 10 | 6 | 15.3 | 0.014 |
| 25 | 18 | 9 | 5 | 15.5 | 0.011 |
| 40 | 18 | 9 | 5 | 15.5 | 0.0087 |
| 60 | 18 | 9 | 5 | 15.5 | 0.0071 |
| 90 | 18 | 9 | 5 | 15.5 | 0.0058 |
| 120 | 18 | 9 | 5 | 15.5 | 0.005 |
| 1440 | 18 | 9 | 5 | 15.5 | 0.0015 |

% SUSPENDED 4.5 4.5 4.5 4.5 3.7 3.7 3.7 3.7 3.7 3.7

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G): SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| Γ | 115 |
|---|---------|
| Г | 0.998 |
| | 2.65 |
| | 3 |
| | 1 |
| Γ | 0.01399 |

FORMULAS: R = H - E - F

S = K[SQRT(L/T)]P = (R/W)100

 $W = (J \cdot 100)/C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

10001 Tod Granicher Project Manager



680 Chesapeake Drive . Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537 Soil, D1-BG-10 Sample Descript:

Method of Analysis: ASTM D422-63

Lab Number: 211-2224 Sampled:

Nov 6, 1992

Received:

Nov 13, 1992 Dec 1, 1992

Analyzed: Reported:

Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

261.03 30.54 88.3

TOTAL

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 1.91 | 0.73 | 0.73 | 99.27 |
| No. 4 | 7.11 | 2.72 | 3.45 | 96.55 |
| No. 10 | 21.52 | 8.24 | 11.69 | 88.31 |
| | | | | |
| PAN | 0.0 | | | |

IDEALTOTAL = (B)

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | •€ | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 18 | 14 | 14.0 | 0.037 |
| 5 | 18 | 17 | 13 | 14.2 | 0.024 |
| 10 | 18 | 16 | 12 | 14.3 | 0.017 |
| 15 | 18 | 15 | 11 | 14.5 | 0.014 |
| 25 | 18 | 15 | 11 | 14.5 | 0.011 |
| 40 | 18 | 14 | 10 | 14.7 | 0.0085 |
| 60 | 18 | 14 | 10 | 14.7 | 0.0069 |
| 90 | 18 | 14 | 10 | 14.7 | 0.0057 |
| 120 | 18 | 13 | 9 | 14.8 | 0.0049 |
| 1440 | 18 | 11 | 7 | 15.2 | 0.0014 |

| % SUSPENDED |
|-------------|
| (P) |
| 19 |
| 18 |
| 16 |
| 15 |
| 15 |
| 14 |
| 14 |
| 14 |
| 12 |
| 9.6 |
| |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):

SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | |
|---------|---|
| 0.993 | į |
| 2.65 | |
| 3 | |
| 1 | |
| 0.01399 | |

30.54

FORMULAS: R = H - E - F

S = K[SQRT(L/T)]P = (R/W) 100

 $W = (J \cdot 100) / C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

Beside Tod Granicher Project Manager



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537 Soil, D1-VW-3

Sample Descript: Method of Analysis: ASTM D422-63

Lab Number: 211-2225 Sampled:

Nov 7, 1992

Received:

Nov 13, 1992 Dec 1, 1992

Analyzed: Dec 8, 1992 Reported:

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

267.21 11.98

95.52

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0IDEAL TOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 1.32 | 0.49 | 0.49 | 99.51 |
| No. 4 | 1.69 | 0.63 | 1.12 | 98.88 |
| No. 10 | 8.97 | 3.36 | 4.48 | 95.52 |
| | | | | |
| PAN | 0.0 | | <u> </u> | |

TOTAL 11.98

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | °C | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 27 | 23 | 12.5 | 0.035 |
| 5 | 18 | 24 | 20 | 13.0 | 0.023 |
| 10 | 18 | 21 | 17 | 13.5 | 0.016 |
| 15 | 18 | 20 | 16 | 13.7 | 0.013 |
| 25 | 18 | 18 | 14 | 14.0 | 0.011 |
| 40 | 18 | 17 | 13 | 14.2 | 0.0083 |
| 60 | 18 | 16 | 12 | 14.3 | 0.0068 |
| 90 | 18 | 15 | 11 | 14.5 | 0.0056 |
| 120 | 18 | 15 | 11 | 14.5 | 0.0049 |
| 1440 | 18 | 12 | 8 | 15.0 | 0.0014 |

| % SUSPENDED |
|-----------------|
| (P) 34 30 |
| 34 |
| 30 |
| 25 24 21 |
| 24 |
| 21 |
| 19 |
| 18 |
| 16 |
| 16 |
| 12 |

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):

SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | F |
|---------|---|
| 0.989 | |
| 2.65 | |
| 3 | |
| 1 | |
| 0.01399 | |

FORMULAS: R = H - E - F

S = K[SQRT(L/T)]

P = (R/W) 100

 $W = (J \cdot 100) / C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

ತಾರಾ

Tod Granicher Project Manager

2112219.ENG <7>



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

600 Bancroft Way

Berkeley, CA 94710 Attention: Tom Paulson Client Project ID:

WO #4537

Soil, D1-VW-7

Sample Descript: Method of Analysis: ASTM D422-63

Lab Number: 211-2226 Sampled:

Nov 7, 1992

Received: Analyzed:

Nov 13, 1992 Dec 1, 1992

Reported:

Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

213.26 14.05

SIEVE TEST FOR **WEIGHT RETAINED** IN NO. 10 SIEVE

IDEAL PAN = 0.0 IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 5.50 | 2.58 | 2.58 | 97.42 |
| No. 4 | 3.91 | 1.83 | 4.41 | 95.59 |
| No. 10 | 4.64 | 2.18 | 6.59 | 93.41 |
| | | <u> </u> | | |
| PAN | 0.0 | | <u>1</u> L | |

TOTAL 14.05

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|----------|-------------|-------------|------|-----------|
| (T) | ℃ | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 20 | 16 | 13.7 | 0.037 |
| 5 | 18 | 19 | 15 | 13.8 | 0.023 |
| 10 | 18 | 19 | 15 | 13.8 | 0.016 |
| 15 | 18 | 19 | 15 | 13.8 | 0.013 |
| 25 | 18 | 18 | 14 | 14.0 | 0.010 |
| 40 | 18 | 17 | 13 | 14.2 | 0.0083 |
| 60 | 18 | 17 | 13 | 14.2 | 0.0068 |
| 90 | 18 | 16 | 12 | 14.3 | 0.0056 |
| 120 | 18 | 16 | 12 | 14.3 | 0.0048 |
| 1440 | 18 | 15 | 11 | 14.5 | 0.0014 |

| 76 SUSPENDED |
|-----------------------------|
| (P) |
| (P) 23 22 22 22 |
| 22 |
| 22 |
| 22 |
| 20 |
| 19 |
| 19 |
| 17 |
| 17 |
| 16 |
| |

& SHISPENDED

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):

HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):

SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| 65 | FC |
|---------|----|
| 0.990 | |
| 2.65 | |
| 3 | |
| 1 | |
| 0.01399 | |

DRMULAS:

R = H - E - FS = K[SQRT(L/T)]

P = (R/W)100

 $W = (J \cdot 100) / C$

 $J = D \cdot G$

SEQUOIA ANALYTICAL

SKEST

Tod Granicher Project Manager

2112219.ENG <8>



680 Chesapeake Drive • Redwood City, CA 94063 (415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.

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Berkeley, CA 94710

Client Project ID:

WO #4537

Soil, D1-VW-11

Received: Analyzed:

Nov 7, 1992 Nov 13, 1992

Sample Descript: Method of Analysis: ASTM D422-63

Dec 1, 1992

Attention: Tom Paulson

Lab Number:

211-2227

Reported:

Sampled:

Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:

(B) WEIGHT RETAINED IN NO. 10 SIEVE:

(C) % PASSING NO. 10 SIEVE:

354.68 96.42 72.81

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

IDEAL PAN = 0.0IDEALTOTAL = (B)

| | WEIGHT | | CUMULATIVE | CUMULATIVE |
|------------|-------------|------------|------------|---------------------------------------|
| SIEVE SIZE | RETAINED, g | % RETAINED | % RETAINED | % PASSING |
| 1½ in. | 0.0 | 0.0 | 0.0 | 100 |
| 3/8 in. | 89.16 | 25.14 | 25.14 | 74.86 |
| Ño. 4 | 3.95 | 1.11 | 26.65 | 73.35 |
| No. 10 | 3.31 | 0.93 | 27.58 | 72.42 |
| PAN | 0.0 | | | · · · · · · · · · · · · · · · · · · · |
| TOTAL | 0.0 | ł | | |

TOTAL [96.42

HYDROMETER TEST

| ELAPSED TIME | TEMP. | HYDROMETER | CORRECTED | | PARTICLE |
|--------------|-------|-------------|-------------|------|-----------|
| (T) | °C | READING (H) | READING (R) | (L) | DIAM. (S) |
| 2 | 18 | 19 | 15 | 13.8 | 0.037 |
| 5 | 18 | 18 | 14 | 14.0 | 0.023 |
| 10 | 18 | 17 | 13 | 14.2 | 0.017 |
| 15 | 18 | 17 | 13 | 14.2 | 0.014 |
| 25 | 18 | 16 | 12 | 14.3 | 0.011 |
| 40 | 18 | 15 | 11 | 14.5 | 0.0084 |
| 60 | 18 | 14 | 10 | 14.7 | 0.0069 |
| 90 | 18 | 14 | 10 | 14.7 | 0.0057 |
| 120 | 18 | 13 | 9 | 14.8 | 0.0049 |
| 1440 | 18 | 10 | 6 | 15.3 | 0.0014 |

| | % SUSPENDED |
|---|-------------|
| _ | (P) |
| I | 17 |
| | 16 |
| L | 15 |
| | 15 |
| | 14 |
| I | 12 |
| I | 11 |
| I | 11 |
| I | 10 |
| | 6.8 |
| | |

CHERCHICE

WEIGHT OF SOIL USED IN HYDROMETER TEST (D): HYGROSCOPIC MOISTURE CORRECTION FACTOR (G): SPECIFIC GRAVITY (ASSUMED):

DISPERSING AGENT CORRECTION FACTOR (E):

MENISCUS CORRECTION FACTOR (F):

TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

| | 65 |
|---|---------|
| | 0.991 |
| | 2.65 |
| | 3 |
| Г | 1 |
| Г | 0.01399 |

FORMULAS: R = H - E - F

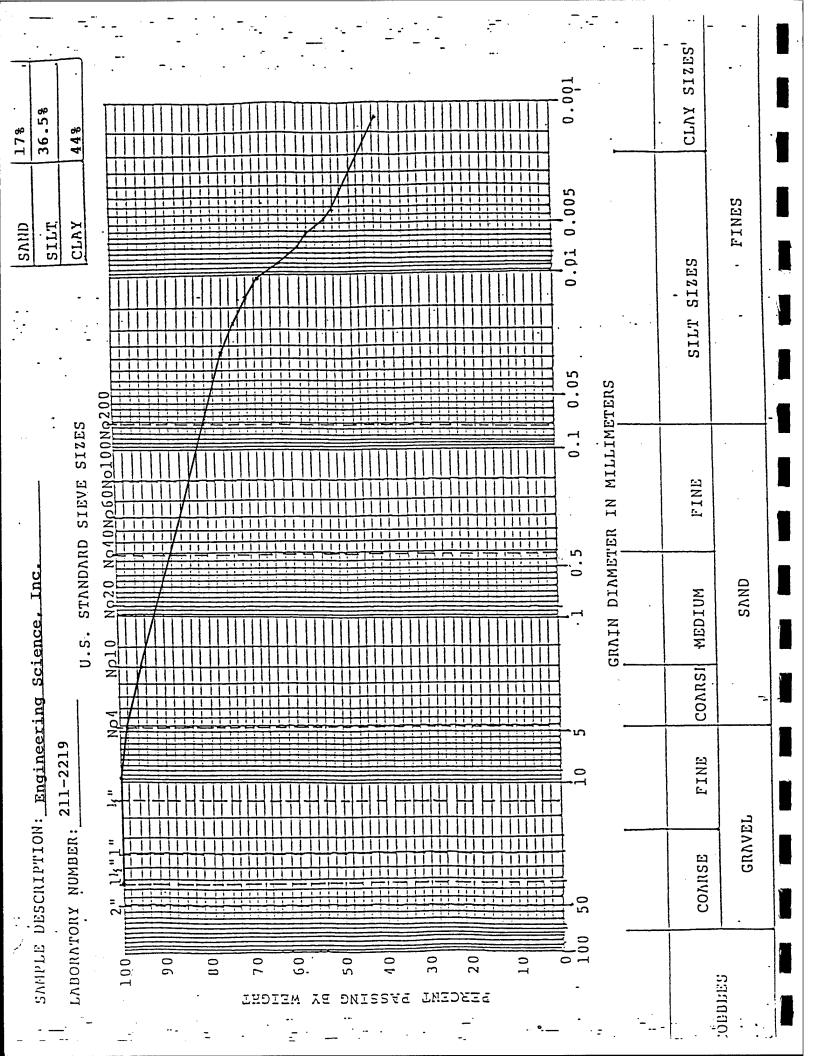
S = K[SQRT(L/T)]

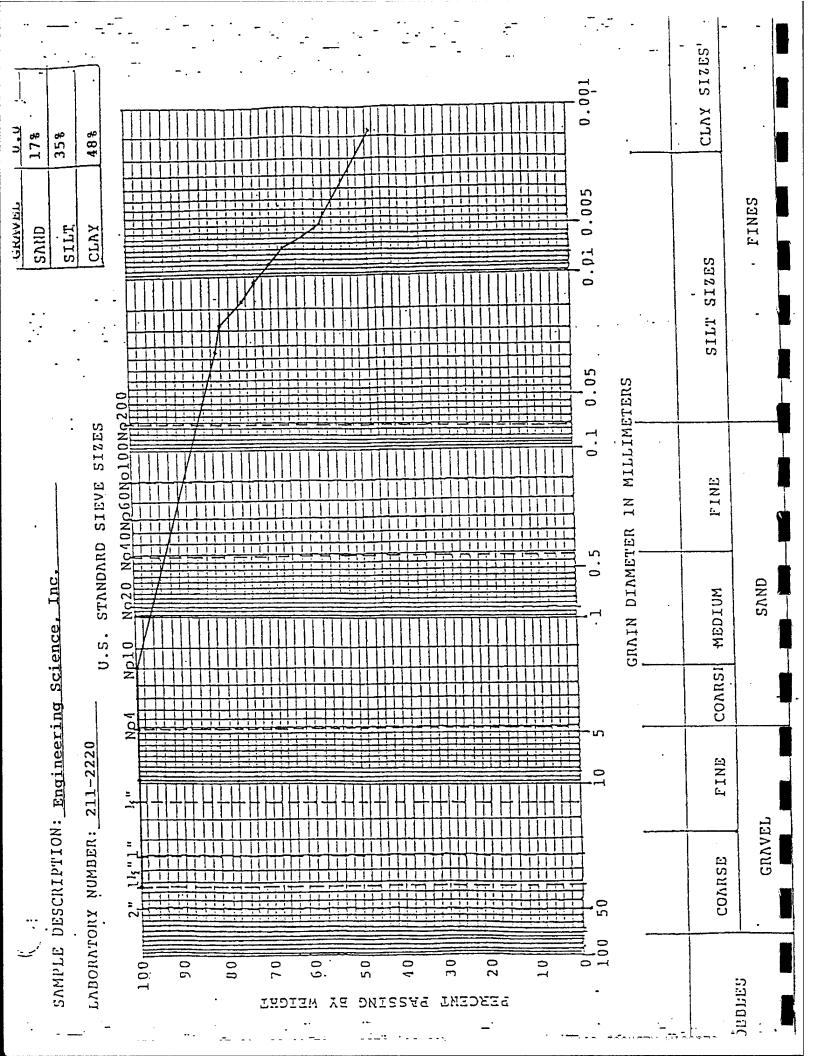
P = (R/W) 100 $W = (J \cdot 100) / C$

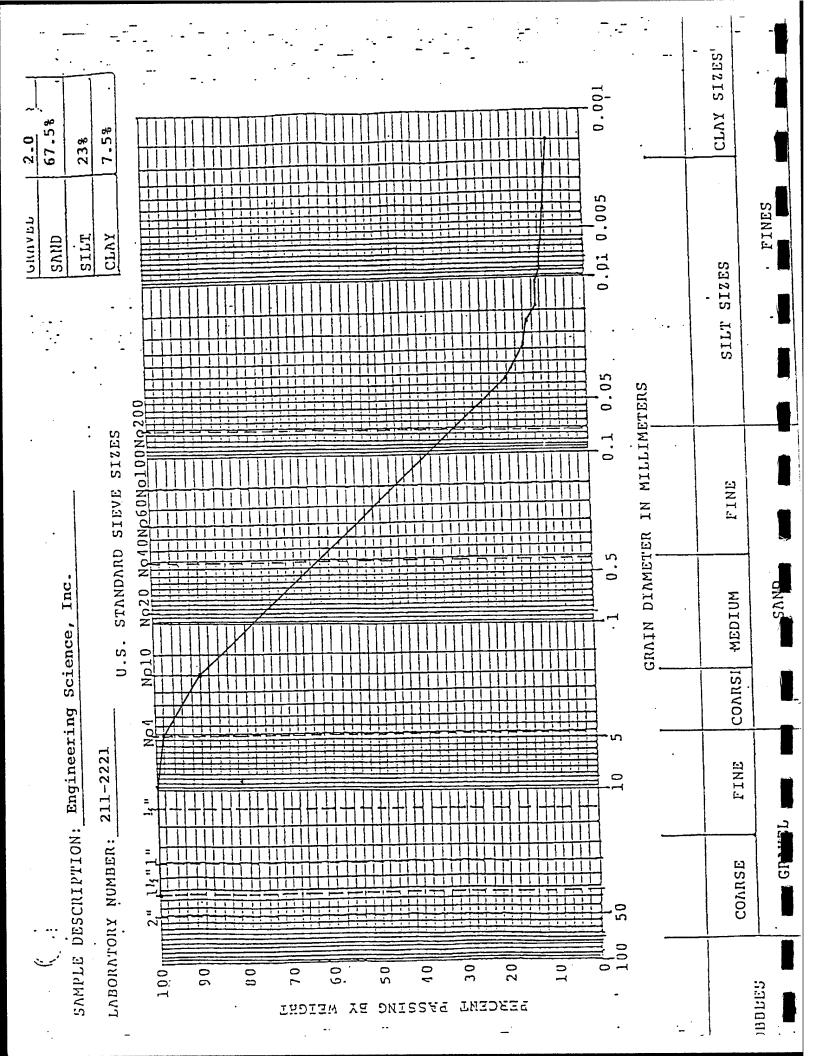
 $J = D \cdot G$

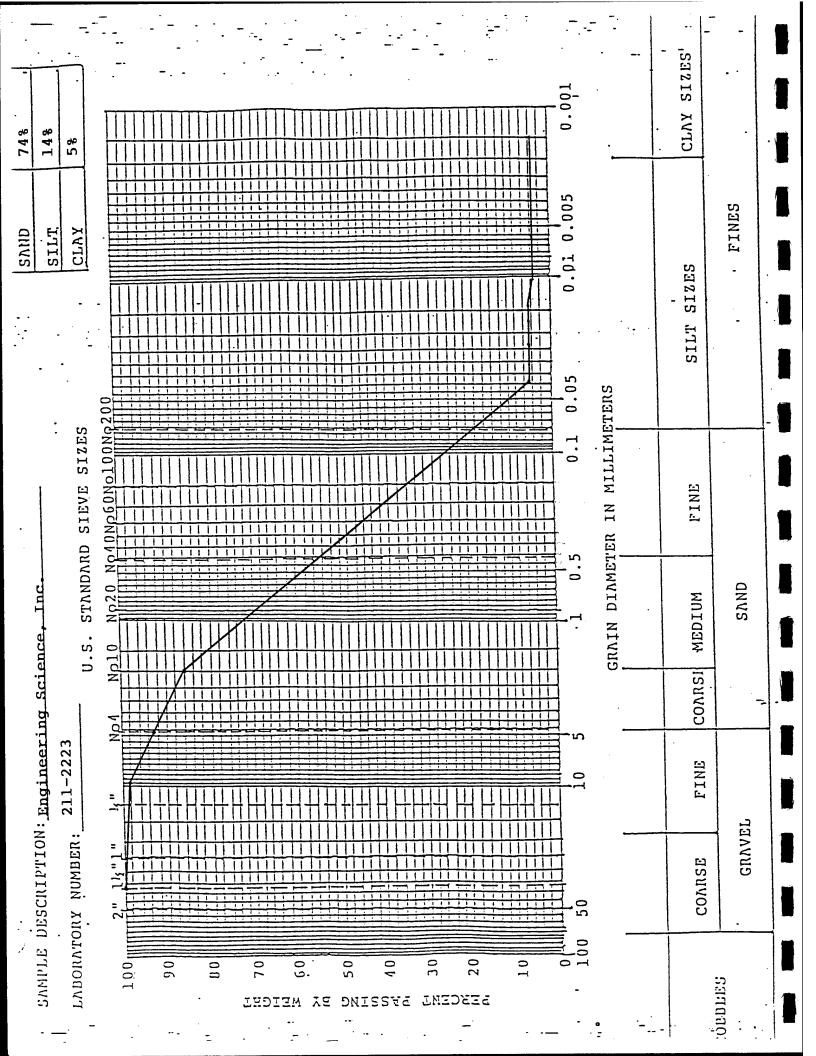
SEQUOIA ANALYTICAL

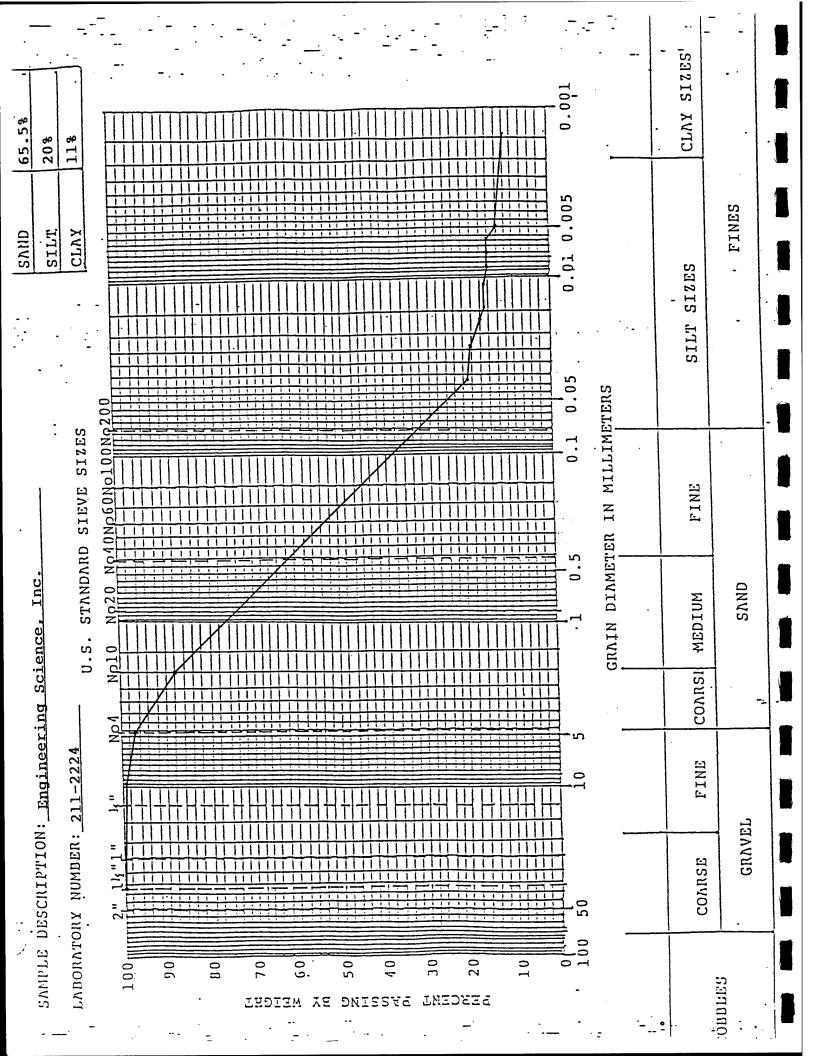
alaet. Tod Granicher Project Manager

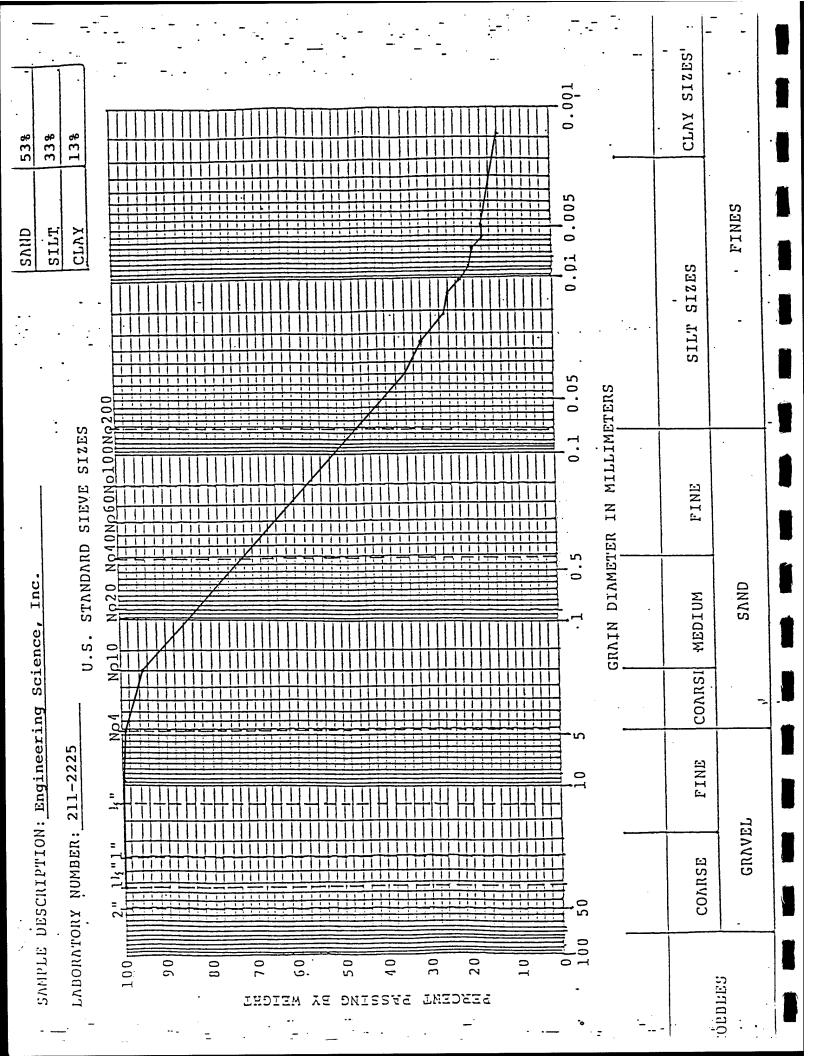


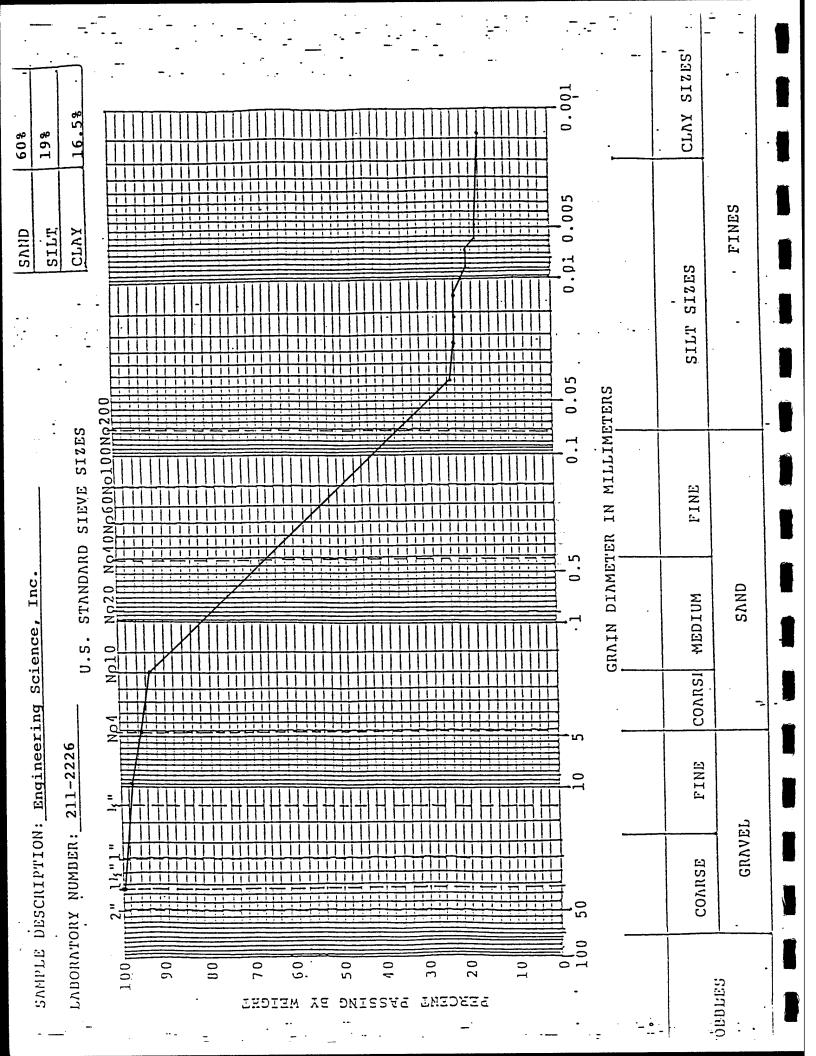


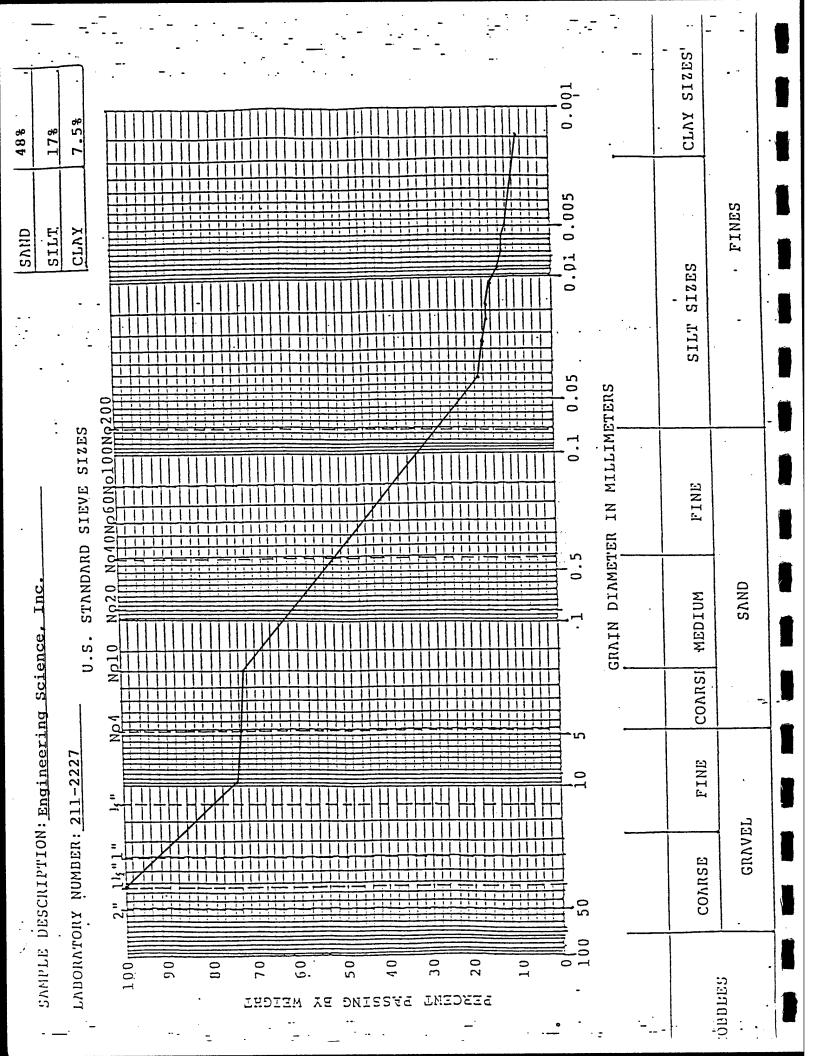












CHAIN OF CUSTODY RECORD FOR WATER BAMPLES

| | | | • | | | | | | | | |
|----------|-------------------------|---------|-----------------------|------------|---------|---------------|-------|----------|--------------|------------|----------------------|
| ES JOB | on no. | PRO | PROJECT NAME/LOCATION | | INA | PREBERVATIVES | TIVES | Ì | REQUIRED | | 70: SEQUID 1A CAB, |
| | •• | · · | 4537. | حمد | rta | | | İ | | | |
| FIELD | CONTACT: | | CA/A. | roppe | ndaro | AHALYBEG | | REQUERED | ЕБ | . <u> </u> | |
| GMIPLE | GAMPLENG NAMES | 3 3 | jenniures | Lond- | H+ 5:51 | | | | | | · · |
| | : | | | 270 6/2 | | | | • | | | |
| | | | | √ / | 313. | | | | | - | |
| DATE | TIME | FIELD | SAMPLE IDENTIFIER | | ! | | | | | | REHARKS |
| 11/9/12 | 10:00 | 02- | 02-1W-10 (4537.01C)9 | / | 7 | . | | | الع | 13219 | KAPINT RESULT ON DRY |
| | 09:91 | 02- | | / | | | | | | 3 | Sul Ausis. Use Moi's |
| - | -> | 02- | 02-VW-3(4537, 03C) . | 7 | | | | . | | 78 | For Reporting units. |
| 16/0/11 | 1760 | 2-10 | 34 | 7 | \ | | | | - 1 | 7 | PADOLT METHOD BLOWKE |
| 1/2/42 | 1760 0970 | 9-10 | 9 (| 7 | 7 | | | | . | 8 | ps/1850. |
| 1/6/92 | 1700 | | 01-86-10 (4537.060) | 7 | / | | | | | 7 | (10 Day TA). Roper 7 |
| 26/1/// | 0800 | -10 | D1- VW-3(4537.07C) 0 | | 7 | - | | | | 52 | To Tow Prulson ESSL |
| | > | 0/- | 01- VW-7 (4537.08C) " | 7 | / | | | | | 3 | |
| | 0600 | 0/- | VW-11 (4537,090) | 7 | .\ | | | . | <u> </u> | 4 | |
| | | | | | (| | \ | | • | | |
| FIELD | custobx | 7 | neringulbued by: | , | 9 | dele | 1/2 | | . עם | DATE: // | 1/3/47TIME: 0900 |
| BILLPPED | :NIV U | | AIRBILL # | | зи ис | ON RECEIPT: | | cuaroby | BEALB? | 82 | , TEMP: |
| RECEIV | RECELVED FOR LABORATORY | LABORA | ATORY BY: | . 4 | •. | | | | MQ. | DATE: // | 11/13/92 TIME: 1338 |
| CHALLE | ne Her | الم الم | 11.36 | Ca | 1 | 1 | d | | 4 | 1 | 13-52 1330 |

Baffelle

CHAIN OF CUSTODY RECORD

, co/20 -/ co/

Form No.

70TAL SAMPLES 47

Remarks Received by: Received by: (Signature) (Signature) Containers ło Number Remarks SEUD RESULTS TO. Container No. % JEFF. KITTEL Date/Time Date/Time BATTELLE AVE. 505 KING AVE. SAMPLE TYPE (\/) Relinquished by: (Signature) Relinquished by: (Signature) 1/2 Date/Time 18/11 Received for Laboratory by: Received by: (Signature) Project Tille DOVER AIR FORTE BY 707 405. yes the (Signature) Y02. 1602. 20 91 ₹0 97 8.0, 2091 799 407 DZ-YW-10'-10.5' Received by: BTEX, (Signature) SAMPLE 1.D. 64468 - 0625 'n D2-12-10' - VW - 3 D2 - VW-7' 17-10-809:01 DZ = 1 W- 3 F-89-10 D2 - VW-D2-11-00 D2-1W-Date/Time Date/Time Date/Time D2-1M Ã Relinquished by: (Signature) TIME Relinquished by: (Signature) Relinquished by: (Signature) SAMPLERS: (Signature) 5290-8966 Columbus Laboratorles 20-0-1 26 - 9 - 11 26 - 9 - 11 26 - 9 - 11 26 - 9 - 11 26 - 9 - 11 22-2 11-6-92 11-9-92 26-6-11 26-6-11 76-11-26 -6-11 11-9-92 26 -6-11 26-6-11 26-6-11 DATE(26-6-Proj. No.

COL 118 8V5 CW 10

APPENDIX C SITE ST-04 SOIL GAS PERMEABILITY DATA

Table C-1. Results of Soil Gas Permeability Test at Monitoring Point D1-MPA

| | Pressure | re ("H ₂ O) by Depth | epth | | Press | Pressure ("H ₂ O) by Depth | epth |
|------------|----------|---------------------------------|-------|------------|-------|---------------------------------------|-------|
| Time (min) | 3.0′ | 7.0′ | 11.0′ | Time (min) | 3.0′ | 7.0′ | 11.0′ |
| 0 | 0 | 0 | 0> | 14 | 0.008 | 0.009 | 5.1 |
| 1 | 0 | 0 | 3.1 | 16 | 0.005 | 0.007 | 5.1 |
| 2 | 0 | 0 | 4.0 | 18 | 0.005 | 0.007 | 5.1 |
| 3 | 0 | 0 | 4.3 | 20 | 0.005 | 0.007 | 5.1 |
| 4 | 0 | 0 | 4.5 | 23 | 0.005 | 0.007 | 5.1 |
| 5 | 0 | 0 | 4.7 | 26 | 0.005 | 0.007 | 5.1 |
| 9 | 0 | 0 | 4.8 | 29 | 0.005 | 0.007 | 5.1 |
| 7 | 0 | 0 | 4.9 | 41 | 0.005 | 0.007 | 5.1 |
| 8 | 0.007 | 0.008 | 4.9 | 51 | 0.005 | 9000 | 5.1 |
| 6 | 0.009 | 0.01 | 5.0 | 61 | 0.005 | 0.00 | 4.6 |
| 10 | 0.009 | 0.04 | 5.0 | 71 | 0.005 | 0.007 | 4.5 |
| 12 | 0.00 | 0.011 | 5.0 | 91 | 0.005 | 0.007 | 4.5 |

Table C-2. Results of Soil Gas Permeability Test at Monitoring Point D1-MPB

| | Pressure | re ("H ₂ O) by Depth | epth | | Pres | Pressure ("H ₂ O) by Depth | Depth |
|------------|----------|---------------------------------|-------|------------|------|---------------------------------------|-------|
| Time (min) | 3.0′ | 7.0′ | 10.0′ | Time (min) | 3.0′ | 7.0′ | 10.0′ |
| 0 | 0.025 | 0.01 | 0.02 | 18 | 0 | 0.005 | 0.40 |
| 1 | 0.01 | 0.01 | 0.02 | 20 | 0 | 0.004 | 0.425 |
| 2 | 0.005 | 0.005 | 0.01 | 23 | 0 | 0.005 | 0.425 |
| 5 | 0 | 0 | 0.25 | 26 | 0 | 0.003 | 0.425 |
| 9 | 0 | 0 | 0.30 | 29 | 0 | 0 | 0.45 |
| 8 | 0 | 0.005 | 0.35 | 39 | 0 | 0 | 0.43 |
| 10 | 0 | 0.05 | 0.35 | 49 | 0 | 0 | 0.425 |
| 12 | 0 | 0.005 | 0.40 | 59 | 0 | 0 | 0.425 |
| 14 | 0 | 0 | 0.40 | 69 | 0 | 0.005 | 0.40 |
| 16 | 0 | 0 | 0.425 | 68 | 0 | 0.005 | 0.40 |

Table C-3. Results of Soil Gas Permeability Test at Monitoring Point D1-MPC

| | Pressure (| re ("H ₂ O) by Depth | epth | | Pre | Pressure ("H ₂ O) by Depth | Jepth |
|------------|------------|---------------------------------|-------|------------|------|---------------------------------------|--------------|
| Time (min) | 3.0′ | 7.0′ | 11.0′ | Time (min) | 3.0′ | 7.0′ | 11.0′ |
| 0 | 0.025 | 0.01 | 0.02 | 18 | 0 | 0.005 | 0.40 |
| 1 | 0.01 | 0.01 | 0.02 | 20 | 0 | 0.004 | 0.425 |
| 2 | 0.005 | 0.005 | 0.01 | 23 | 0 | 0.005 | 0.425 |
| 5 | 0 | 0 | 0.25 | 26 | 0 | 0.003 | 0.425 |
| 9 | 0 | 0 | 0.30 | 29 | 0 | 0 | 0.45 |
| 8 | 0 | 0.005 | 0.35 | 39 | 0 | 0 | 0.43 |
| 10 | 0 | 0.005 | 0.35 | 49 | 0 | 0 | 0.425 |
| 12 | 0 | 0.005 | 0.40 | 59 | 0 | 0 | 0.425 |
| 14 | 0 | 0 | 0.40 | 69 | 0 | 0.005 | 0.40 |
| 16 | 0 | 0 | 0.425 | 68 | 0 | 0.005 | 0.40 |

APPENDIX D SITE ST-04 IN SITU RESPIRATION TEST DATA

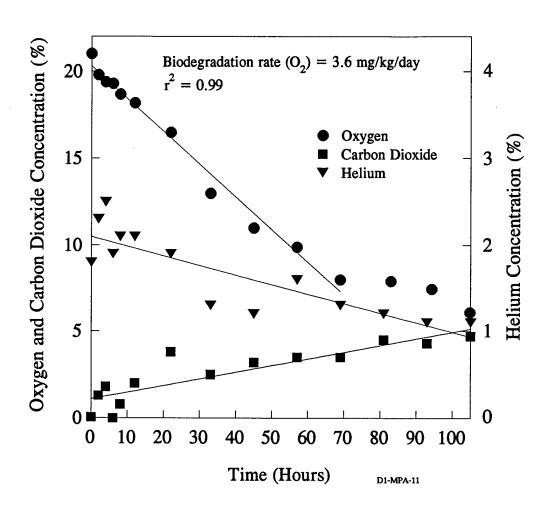


Figure D-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPA-11.0'

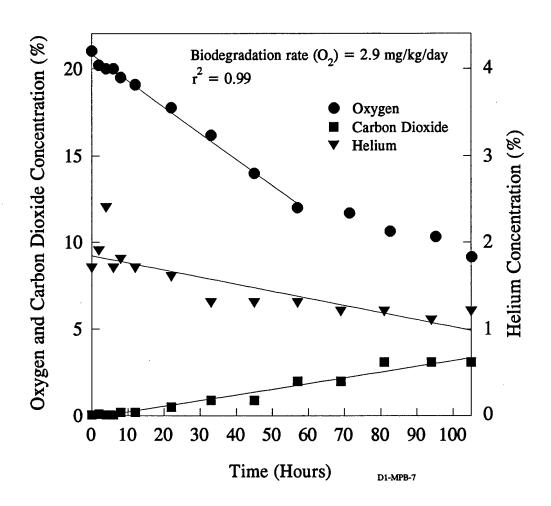


Figure D-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPB-7.0'

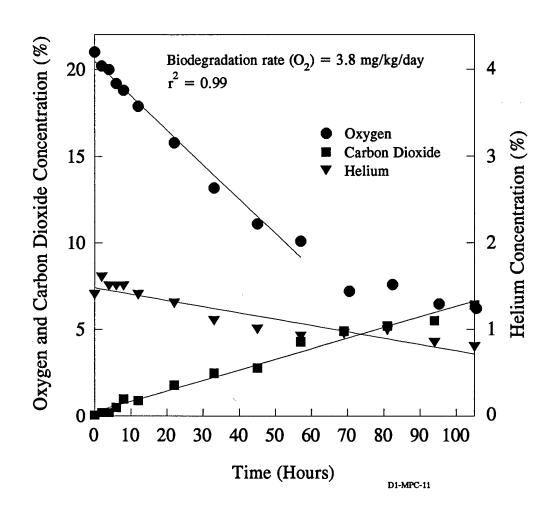


Figure D-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPC-11.0'

APPENDIX E NORTH STORAGE TANK FARM SOIL GAS PERMEABILITY DATA

Table E-1. Results of Soil Gas Permeability Test at Monitoring Point D2-MPA

| | Pressure (| re ("H ₂ O) by Depth | epth | | Pres | Pressure ("H ₂ O) by Depth | Depth |
|------------|------------|---------------------------------|------|------------|------|---------------------------------------|--------------|
| Time (min) | 2.5′ | 6.0′ | 9.5′ | Time (min) | 2.5′ | 6.0′ | 9.5′ |
| 0 | 0 | 0 | 0 | 16 | 2.8 | 0.02 | 0.015 |
| 1 | 1.2 | 0 | 0 | 18 | 2.8 | 0.04 | 0.02 |
| 2 | 1.7 | 0 | 0 | 20 | 2.9 | 0.025 | 0.01 |
| 3 | 1.9 | 0.13 | 0 | 23 | 2.9 | 0.095 | 0.02 |
| 4 | 2.2 | 0.085 | 0 | 26 | 2.9 | 0.040 | 0.02 |
| 5 | 2.2 | | | 29 | 3.0 | 0.02 | 0.02 |
| 9 | 2.4 | 0.25 | 0 | 34 | 3.1 | 090'0 | 0.02 |
| 7 | 2.4 | 0.21 | 0 | 39 | 3.1 | 0.03 | 0.02 |
| & | 2.5 | 0.23 | 0 | 49 | 3.1 | 0.04 | 0.02 |
| 6 | 2.5 | 0.09 | 0 | 59 | 3.2 | 0 | 0 |
| 10 | 2.5 | 0.045 | 0 | 74 | 3.4 | 0 | 0 |
| 12 | 2.5 | 0.03 | 0 | 68 | 3.4 | 0 | 0 |
| 14 | 2.7 | 0.04 | 0 | 104 | 3.5 | 0 | 0 |
| | | | | | | | |

Table E-2. Results of Soil Gas Permeability Test at Monitoring Point D2-MPB

| | Pressure | re ("H ₂ O) by Depth | epth | | Pres | Pressure ("H,O) by Depth | Depth |
|------------|----------|---------------------------------|------|------------|------|--------------------------|-------|
| Time (min) | 2.5′ | 6.0′ | 9.5′ | Time (min) | 2.5′ | ,0'9 | 9.5′ |
| 0 | 0 | 0 | 0 | 18 | 1.35 | 0 | 0 |
| 1 | 9.0 | 0 | 0 | 20 | 1.37 | 0.01 | 0 |
| 2 | 0.75 | 0 | 0 | 23 | 1.40 | 0.02 | 0 |
| 3 | 06.0 | 0.01 | 0 | 26 | 1.40 | 0 | 0 |
| 4 | 1.0 | 0 | 0 | 29 | 1.42 | 0.01 | 0 |
| 5 | 1.05 | 0.04 | 0 | 34 | 1.51 | 0 | 0 |
| 9 | 1.1 | 0 | 0 | 39 | 1.52 | 0 | 0 |
| 8 | 1.1 | 0 | 0 | 44 | 1.52 | 0 | 0 |
| 6 | 1.15 | 0 | 0 | 59 | 1.60 | 0 | 0 |
| 10 | 1.15 | 0 | 0 | 74 | 1.63 | 0 | 0 |
| 12 | 1.17 | 0 | 0 | 68 | 1.63 | 0 | 0 |
| 14 | 1.27 | 0 | 0 | 104 | 1.67 | 0 | 0 |
| 16 | 1.30 | 0.02 | 0 | | | | |
| | | | | | | | |

Table E-3. Results of Soil Gas Permeability Test at Monitoring Point D2-MPC

| Time (min) 2.5' 6.0' 9.5' 0 0 0 0 1 0.23 0.21 0.15 2 0.40 0.40 0.35 3 0.50 0.50 0.49 4 0.65 0.60 0.60 5 0.67 0.65 0.64 6 0.69 .69 0.67 8 0.75 0.75 0.74 9 0.75 0.77 0.75 10 0.77 0.77 0.76 10 0.77 0.75 0.76 10 0.77 0.75 0.76 | | Pressure (| re ("H ₂ O) by Depth | epth | | Pres | Pressure ("H ₂ O) by Depth | Depth |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|---------------------------------|------|------------|------|---------------------------------------|-------|
| 0 0 0 0.23 0.21 0.40 0.40 0.50 0.50 0.65 0.60 0.67 0.65 0.73 0.75 0.75 0.77 0.77 0.85 0.85 | Fime (min) | 2.5′ | ,0'9 | 9.5′ | Time (min) | 2.5′ | ,0'9 | 9.5′ |
| 0.23 0.21 0.40 0.40 0.50 0.50 0.65 0.60 0.67 0.65 0.70 0.73 0.75 0.75 0.75 0.77 0.77 0.77 0.75 0.77 0.85 0.85 | 0 | 0 | 0 | 0 | 16 | 1.89 | 0.89 | 0.87 |
| 0.40 0.40 0.50 0.50 0.65 0.60 0.67 0.65 0.70 0.73 0.75 0.75 0.75 0.77 0.77 0.77 0.77 0.77 0.85 0.85 | 1 | 0.23 | 0.21 | 0.15 | 18 | 0.91 | 06:0 | 0.88 |
| 0.50 0.50 0.65 0.60 0.67 0.65 0.69 .69 0.70 0.73 0.75 0.75 0.75 0.75 0.77 0.77 0.78 0.85 | 2 | 0.40 | 0.40 | 0.35 | 20 | 0.91 | 0.91 | 06.0 |
| 0.65 0.60 0.67 0.65 0.69 .69 0.70 0.73 0.75 0.75 0.77 0.77 0.77 0.77 0.77 0.77 0.85 0.85 | 3 | 0.50 | 0.50 | 0.49 | 23 | 96'0 | 0.95 | 0.94 |
| 0.67 0.65 0.69 .69 0.70 0.73 0.75 0.75 0.77 0.77 0.77 0.77 0.77 0.77 0.85 0.85 | 4 | 0.65 | 09.0 | 09.0 | 26 | 96:0 | 0.97 | 0.94 |
| 0.69 .69 0.70 0.73 0.75 0.75 0.77 0.77 0.77 0.77 0.85 0.85 | 5 | 0.67 | 0.65 | 0.64 | 29 | 96'0 | 96:0 | 0.95 |
| 0.70 0.73 0.75 0.75 0.75 0.77 0.77 0.77 0.77 0.77 0.85 0.85 | 9 | 69:0 | 69. | 0.67 | 34 | 1.0 | 1.0 | 1.0 |
| 0.75 0.75 0.75 0.77 0.77 0.77 0.85 0.85 | 7 | 0.70 | 0.73 | 0.71 | 39 | 1.10 | 1.12 | 1.09 |
| 0.75 0.77 0.77 0.77 0.85 0.85 | · • | 0.75 | 0.75 | 0.74 | 49 | 1.10 | 1.10 | 1.0 |
| 0.77 0.77 0.85 0.85 | 6 | 0.75 | 0.77 | 0.75 | 59 | 1.10 | 0.022 | 0.02 |
| 0.85 0.85 | 10 | 0.77 | 0.77 | 0.76 | 74 | 1.10 | 0 | 0 |
| | 12 | 0.85 | 0.85 | 0.83 | 68 | 1.10 | 0 | 0 |
| 14 0.87 0.87 0.85 | 14 | 0.87 | 0.87 | 0.85 | 104 | 1.13 | | |

APPENDIX F

NORTH STORAGE TANK FARM IN SITU RESPIRATION TEST DATA

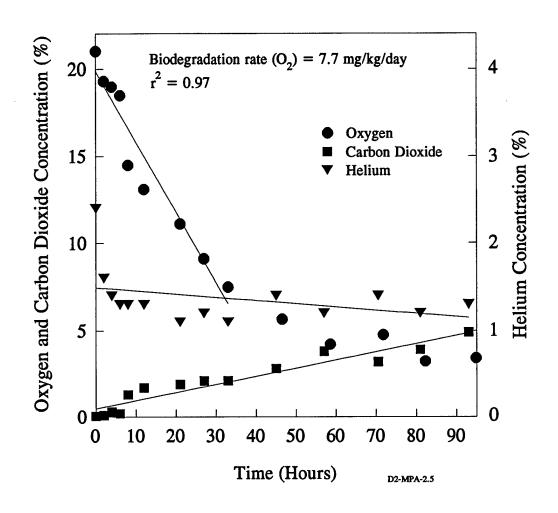


Figure F-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-2.5'

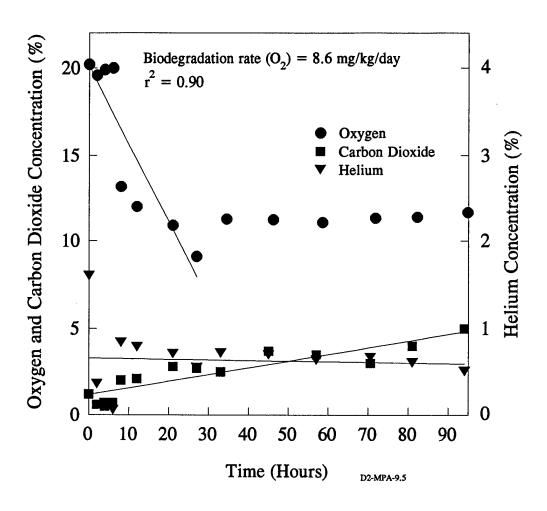


Figure F-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-9.5'

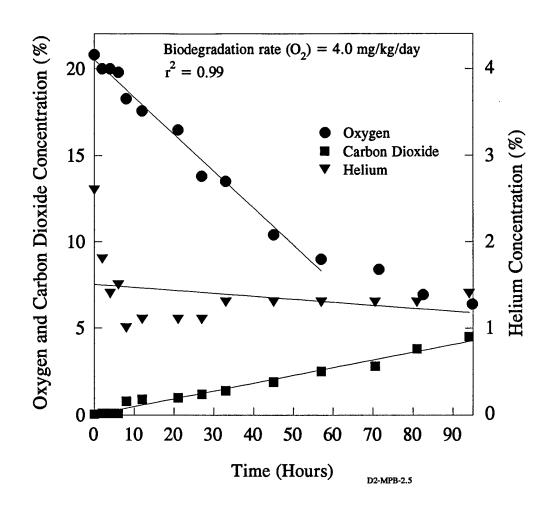


Figure F-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPB-2.5'

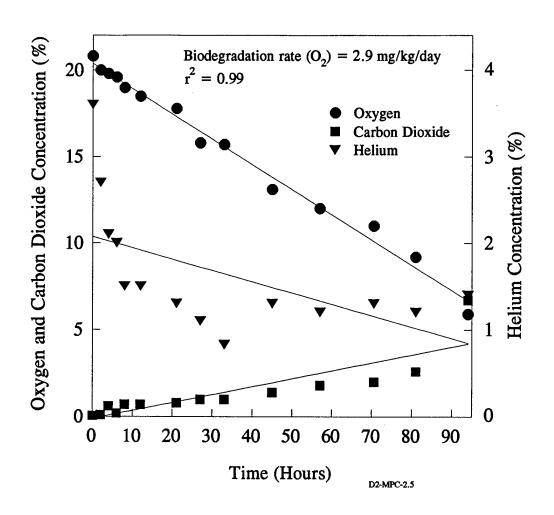


Figure F-4. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPC-2.5'

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